AQUATIC ENVIRONMENT AND FISHERIES STUDY

PROPOSED SAWTOOTH NATIONAL RECREATION AND WILDERNESS AREAS

by

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INTRODUCTION

The proposed Sawtooth National Recreation Area* lies within the rugged area of central Idaho. The area is composed of high elevation watersheds forming the headwaters of the Salmon, Boise, Payette, and Big Wood Rivers which lend themselves to the production of salmonoid fisheries. Thus, it contains some of the more important spawning and rearing areas for steelhead, salmon, and the different trout species in Idaho. The proposed SNRA provides spawning areas for anadromous fish important not only to the sportsmen, but also to the sport and commercial fishing industry in the Columbia River and off-ocean areas of the Pacific. Thus, it is not only an onsite fishery and recreation producer, but further contributes to the Pacific Northwest and foreign countries.

Anadromous adult steelhead and salmon runs from the ocean penetrate the proposed SNRA from the Salmon River and the East Fork Salmon River and spawn in these rivers and their many tributaries. These two species have declined drastically in the Salmon River system due to both downriver (lower Snake and Columbia) and upriver degraded conditions. The aquatic environment within the proposed SNRA has also been degraded due to land and water uses to the point it is also limiting survival of salmon, steelhead, and trout.

*Will be referred to as SNRA in remainder of the study.

Fishing, as outlined in the "Sawtooth Area Study," is one of the major attractions of the area. Undoubtedly, the presence of salmon and steelhead traveling over 800 miles to spawn, the beautiful high elevation tarn lakes, and the fast falling white turbulent streams with slower areas for fishing, centered the people towards acknowledging this area as a high value recreation area.

Most of the lakes, rivers, and streams provide a good environment for the many species of game fish. While the main river systems and their major tributaries always supported resident fish, and in many cases anadromous fish, most of the high mountain lakes were originally barren. With the coming of the white man, most of these lakes and some of the streams capable of supporting fish have been artifically stocked.

The proposed SNRA has long been recognized for its outstanding scenery and recreational qualities of which salmon, steelhead, and trout fisheries are important recreation contributors. The waterscape within this area offers the necessary requirements for the superlative fishery resource. Proper management would greatly enhance this resource. It offers an excellent opportunity to increase the value of the fishery resource to the people by more intensive management of the aquatic environment.

Because it is a high elevation area, it had the opportunity of being heavily glaciated. This not only formed a beautiful, esthetic, scenic condition, but also developed a variety of waterscapes that due to their pristine, satisfying conditions are much sought after as a trout fishery. In the higher elevations, as the deglaciation period uncovered the landscape, it left

behind hundreds of small mountain lakes and steep gradient streams offering a different and unique type of fishing to the recreationist.

Native game fish in the area now consist of cutthroat trout; Dolly Varden; rainbow trout; whitefish; kokanee, chinook, and sockeye salmon; and steelhead trout. Introduced species include brook trout, California golden trout, and grayling. Nongame species include squawfish, suckers, redside shiner, dace, chiselmouth chub, and sculpin. A following section on fish species evaluates the individual species and goes deeper into their status.

PURPOSE AND OBJECTIVES

The main purpose of this report is to fulfill the information needed by the SNRA studies to help evaluate the aquatic environment and its resulting fishing resource. The information in this report will be meshed into reports of other disciplines to lead to a total environmental report for the proposed SNRA.

Other purposes of this study would be to outline the present status of the aquatic habitat and its fishery resource to determine any adverse conditions within the aquatic environment, to determine the factors causing adverse conditions within the aquatic environment, and to outline suggestions as to types of management necessary if the fishery resource is to be adequately protected and managed. To date, studies of the aquatic environment and its fisheries within this study are limited and do not allow totally the fulfilling of the purposes and objectives. It does point out the need for further studies to obtain the information necessary before the waters can be better managed at a project planning level. The objectives of this report are (1) mainly to provide what data and understanding is available so the land and water manager can better determine his management direction and goals, and (2) provide available data and information to be mixed with that of other disciplines to help in the total analysis and working relationship of this land area. To date, very little management of the aquatic environment has been attempted. The findings in this report are only a beginning towards what is needed to describe and work the aquatic environment into overall total management programs.

This study in conjunction with future studies should be directed to obtain the necessary resource data to help meet the following needs:

1. To obtain information to describe the present status of the aquatic environment.

2. To detect and be able to predict changes as they occur or that may occur within the systems that would result from land or water uses.

3. To establish the documentation data on certain top priority aquatic habitats so monitoring systems can be established.

4. To assess the chemical, physical, and biological potential of lakes considered to be barren of fish populations in order that the fishery resource could be fully developed.

5. To obtain the background and understanding that are needed so the land and water managers can work the waterscape into the long term management goals.

6. To assess the chemical, physical, and minor biological characteristics of lakes presently containing fish populations to determine their potential.

7. To assess stream areas to determine their potential to the fishery resource.

8. To determine what management actions might be taken to increase the quality and the quantity of the recreational use of the fishery resource.

9. To provide the Forest and the District with the necessary information of the type that can be worked into the Forest and District multiple use plans.

10. To provide aquatic environment inputs into the total management plan so information will be available to help the land manager conduct land uses in the best compatibility with the aquatic environment.

11. To provide the necessary information that can be meshed with that of other disciplines to lead to total environmental management.

GENERAL AQUATIC ENVIRONMENT

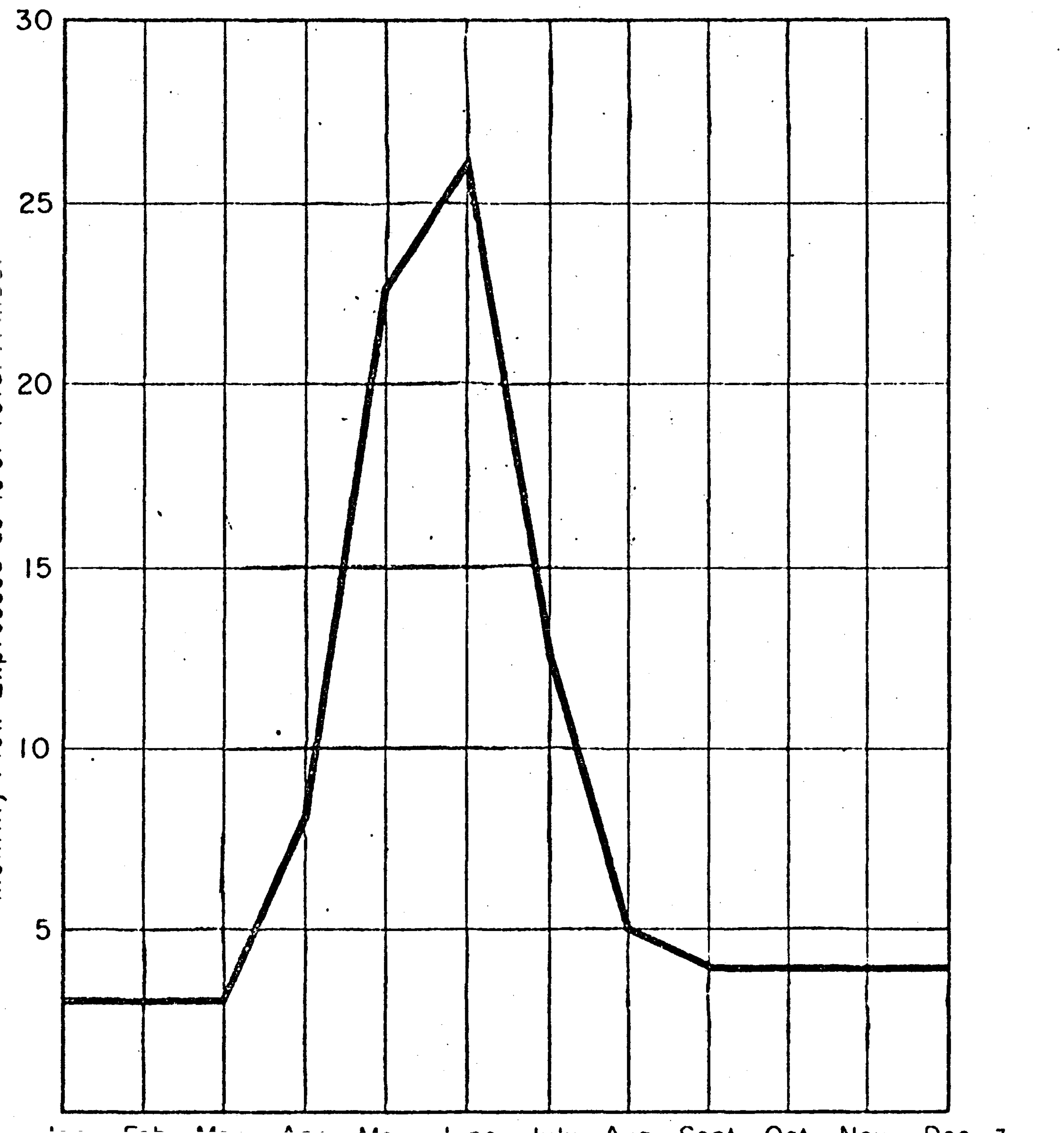
Streams in the proposed SNRA area are endowed with salmon, steelhead, and trout. These streams, which are typified by the salmonoid biotype, have relatively cool, clear waters which are directly affected by climatic conditions. The majority of the streams are rapid flowing with steep gradients, but on the lower depositional lands with their lower energy flows they are capable of providing good fisheries.

Total water yields from the study area watersheds are quite high, averaging approximately 1.5-acre feet per acre or higher. The higher watershed elevations provide an abundant quantity (except under man's influences and changes) of high quality water to take care of the needs of the fishery resource. Lakes within the drainage trap and contain portions of this water, allowing longer term use for perpetuation of the established fisheries.

Like many Western watersheds, the drainages have high and low streamflow regimen (Figure 1). This results in two annual, critical periods in both the lake and stream environment which govern fish growth and survival. One critical period comes during high peak flows in combination with increased energy flows and abrasive or suffocating materials. The second, and often more critical period, is during low flow conditions which are sometimes coupled with winter ice and snow effects. During this period, many stream-fed lakes will go dry or lose their dissolved oxygen due to an unequal relationship between COD demand and oxygen production or addition.

During this low flow conditions, man has compounded the problem through his many stream diversions located throughout the study area. The waterscapes below stream diversions become badly degraded due to loss of the environment.

Figure 1 Total monthly average flow expressed as percent of total annual flow for the mean of streams in the study area.



These high elevation environments are low energy (organic) environments, low immature systems that history has had little effect in pushing toward maturity These delicate systems react immediately to stress. Salmon, steelhead, and most trout need immature systems to complete their life cycles. The individual ecosystem, such as spawning areas, are mainly from a few years to a few hundred years old with some less than a year and constantly changing. These immature low energy (organic) systems can have their boundaries changed very easily by the addition or changes of energies. The boundaries of these systems need to be constantly documented and monitored.

Fluvial

Although streams in the State of Idaho make up only 22 percent of the available water surface, they receive 56 percent (1966) of the fishing pressure and supply about 65 percent of the harvest (Gebhards). Therefore, good fishing streams are in great demand.

Because the numbers and kinds of fish dwelling in streams are governed by the flow and energy indexes--and these indexes vary greatly within the study area, there is naturally great variability of a stream to support fish. Streams with large variation of flow and energy (plus temperature ranges) provide a less stable environment and, consequently, they produce fewer fish. Much of the area, streamwise, is characterized by high gradient, high energy, and greatly fluctuating streams which offer poor habitat for salmonoid species. There are exceptions to this, such as the Main Salmon River, Valley Creek, Big Wood River, and East Fork Salmon River. Also, even in steep gradient stream environments, there are glaciated valleys and depositional areas that decrease energy flows and allow the aquatic environment requirements that are

necessary to develop and produce good conditioned fish populations. Over most of the area, water temperatures are within tolerance levels for salmonoids, as proven by existing salmon, steelhead, and trout populations.

Like some lakes, many miles of streams contain populations of nongame fish species. These species can limit the potential of the game fisheries.

As will be discussed later, waters (for irrigation) are diverted into the fields at a time when the stream regimen hits its low point. Thus, when the water is in greatest demand for the fishery resource, it is diverted for irrigation. Waters used for irrigation in portions of the lower elevation study area are allowed to flow back into the stream, thus it could reduce environment suitability (both "onsite and offsite") by increasing sediment loads, total solids, fertility, and water temperatures. High water temperatures plus higher sediment loads in offsite river sections, are major contributors responsible for reducing numbers of upstream moving adult salmon and steelhead destined for the study area and young smolts leaving the study area and attempting to reach the ocean.

The annual runs of salmon and steelhead trout entering the Salmon River are influenced by the availability and quality of the water in the tributary streams which originate in the SNRA area. The lifegiving waters leaving the area determine to a great extent the value of many of the downriver impoundments and what they contribute as a fishery resource.

Lacustrine

From the moment of their formation, the lakes within the study area begin to disappear. This is brought about by the erosion of the barrier at the exit

of the lake and the deposition of detrital and organic matter, such as deltas and bottom deposits. Undoubtedly, the area had much more and better lacustrine aquatic environment potential 10,000 years ago than it has now.

Glaciation has been responsible for the formation of most of the lakes. The lakes which occur mainly in the higher elevations receive the majority of their inflow as a result of melting snow, which lies on the surface of the parent materials. Thus, the lakes within the area can and do differ in fertility potential due to aquifers of the different lakes contacting different types and combinations of soils and in turn lakes can vary greatly in their ability to produce a fishery.

Because many of the lakes lie in granitic basins with the aquifer also draining granitic materials which are quite water insoluable, it follows naturally that water in high mountain lakes of this type is usually lacking in mineral content, which in turn helps determine fish growth and survival, In other lake basins draining sedimentary, porphyries, or volcanics, the incoming waters can be more fertile and, if so, will usually support a larger population of fish per unit area.

As will be demonstrated later, many of the lakes are far along in the aging process to where they can no longer support a fishery. One of the first requirements of the lacustrine habitat to support fish at this elevation is depth. If it doesn't have sufficient depth, then this must be counterbalanced by water inflow.

From the previous discussion, it has been recognized that a lake is not an independent entity, but that it is grossly influenced by conditions and

activities of the surroundings. Thus, all lakes tend to be different and the only way to understand them is to study each one individually.

There are many factors that lower the ability of the lacustrine environment to produce a fishery resource. Shallow depth, low inflow of waters, low mineral content, type and amount of shoal area, etc., are some of the reasons for poor environmental conditions and in turn poor fisheries.

Most of the high mountain lakes have cold, year-round water temperatures. Oxygen levels are usually at saturation and do not go below this until ice cover forms. Most of the lakes are poor in nutrients, therefore plankton is also low. These lakes have very delicately balanced environments that can be changed from their natural state immediately by stresses from the surroundings. Activities near these lakes could have effects on the aquatic environment unless programed carefully.

FISH SPECIES

Historical records show that salmon and steelhead once extensively utilized the Salmon, Payette, and Boise Rivers and their tributaries. Both of these species migrated over 800 miles each way to the ocean and back to utilize the headwater streams in the proposed SNRA for completion of their life cycles.

At one time, salmon and steelhead entered the west side of the SNRA area, via the Snake River drainage, spawning and rearing on the west slope streams of the Sawtooth Range. Dam construction in the early 1920's blocked fish from entering via the Boise and Payette River systems. At this time, salmon and steelhead gain entrance to the area only via the Salmon River. The Salmon River drainage provides spawning and rearing areas for more spring and summer chinook than any other drainage in the Columbia River system. At one time, salmon and steelhead were blocked off from the proposed SNRA via the Main Salmon River due to the construction of Sunbeam Dam (above the confluence of Yankee Fork Creek) for power generation for mining and milling operations. It was later blown out and salmon and steelhead runs again established themselves within the area.

The SNRA contains an abundance of different fish species represented by both the anadromous and resident groups. The following is a checklist of the species known to be in the system:

Anadromous

1. Chinook salmon - *Oncorhynchus tshawytscha* (Walbaum)
2. Sockeye salmon - *Oncorhynchus nerka* (Walbaum)

Table 1 List of fish species present or one-time stocked in the proposed Sawtooth National Recreation Area.

	Common Name	Scientific Name	Abundant	Abundance Common	Low	Absent
	Game Fish			1/	2/	
INDIGENOUS	Cutthroat	*Salmo clarki* Richardson		x	x	
	Dolly Varden	*Salvelinus malma* (Walbaum)		x		
	Rainbow	*Salmo gairdneri* Richardson	x			
	Whitefish, mountain	*Prosopium williamsoni* (Girard)	x			
	Kokanee	*Oncorhynchus nerka* (Walbaum)		x		
	Sockeye	*Oncorhynchus nerka* (Walbaum)			x	
	Salmon spring chinook	*Oncorhynchus tschawytscha* (Walbaum)		x	x	
	Salmon summer chinook	*Oncorhynchus tschawytscha* (Walbaum)			x	
	Steelhead	*Salmo gairdneri* Richardson		x		
EXOTIC	Brook	*Salvelinus fontinalis* (Mitchell)		x		
	Golden trout	*Salmo aqua-bonita* Jordon			x	
	Grayling	*Thymallus arcticus* (Pallas)			x	
	Salmon Atlantic	*Salmo salar* Linnaeus				x
	Smelt	*Osmerus mordax* (Mitchell)				x
	Sunapee golden	*Salvelinus alpinus* (Linnaeus)				x
NONGAME	Squawfish	*Ptychocheilus oregonensis* (Richardson)		x		
	Sucker	*Catostomus spp*	x			
	Redside shiner	*Richardsonius balteatus* (Richardson)		x		
	Dace	*Rhinichthys spp*		x		
	Chiselmouth chub	*Acrocheilus alutaceus* Agassiz			x	
	Sculpin	*Cottus spp*	x			
	Lamprey	*Lampetra tridentata* (Gairdner)			x	

1/ Yellowstone cutthroat
2/ Native fluvial cutthroat

3. Steelhead trout - Salmo gairdneri (Richardson)

4. Lamprey - Lampetra tridentata (Gairdner)

Resident

5. Mountain whitefish - Prosopium williamsoni (Girard)

6. Cutthroat trout - Salmo clarki (Richardson)

7. Rainbow trout - Salmo gairdneri (Richardson)

8. Brook trout - Salvelinus fontinalis (Mitchell)

9. Dolly Varden - Salvelinus malma (Walbaum)

10. Squawfish - Ptychocheilus oregonensis (Richardson)

11. Dace - Rhinichthys sp.

12. Redside shiner - Richardsonius balteatus (Richardson)

13. Mountain sucker - Pantosteus platyrhynchus (Cope)

14. Largescale sucker - Catostomus macrocheiulus (Girard)

15. Sculpin - Cottus sp.

The fine-scaled sucker may also be present in the area. The wide variety of species demonstrates the many different types of ecosystems.

Anadromous

Spring Chinook

The spring chinook run enters the lower Columbia River mainly in April and May. This run moves through the lower Salmon River mainly in May and June and enters the proposed SNRA area during July and August. Despite fish passage problems encountered by both juvenile and adult spring chinook at Columbia and Snake River dams, the upriver spring chinook run is maintaining itself. The run in 1969 was the fifth highest on record since counting began in 1938 at Bonneville Dam. The largest run of 281,000 fish occurred

in 1955; the smallest run, totaling 56,300 fish, was recorded in 1944. The run in 1970 was 176,300 fish. The total run at the Bonneville Dam does not appear to be either increasing or decreasing in attendance. However, this is not the case in headwater areas due to degraded conditions of the complete river system.

Although the upriver spring chinook run seems to be holding its own, the heavy stresses received the past 3 years, due to nitrogen gas disease, could start showing even more drastically in the 1972 adult returns. Downriver nitrogen disease has had heavy mortality on salmon and steelhead destined for the SNRA.

The 1970 chinook salmon sport catch (composed mainly of spring chinook) in Idaho dropped from 13,000 in 1969 to 5,500. This was the lowest catch on record since 1954, except for 1965 when all seasons were closed. A sharp decrease in angler participation, due to new permit charges, and an unknown loss from nitrogen gas disease, contributed to the catch decrease. The SNRA contributes approximately 53 percent of the State's salmon harvest.

During 1969, about 42 percent (73,000) of the spring chinook counted over Bonneville Dam failed to pass over McNary Dam. Despite the interdam losses a total of 51,895 spring chinook passed Ice Harbor Dam, the largest number since counting began in 1962. However, these fish weakened by disease and nitrogen gas damages begin to die off after passing the last dam. Annual spawning ground redd counts confirmed what was suspected by this time--that at least 50 percent of the spring chinook died between Lower Monumental Dam and the spawning grounds.

These runs show the magnitude of downriver limiting factors that determine the status of the salmon fishery in the SNRA area. As problems and limiting factors are buffered or eliminated and downriver future dam construction or water management practices does not cause additional roadblocks, the stocks of salmon and steelhead will increase. It is very possible, with the success now being gained in the artificial methods of creating stocks, that combined with more optimum downriver conditions, the SNRA may see more salmon and steelhead returning than ever before in history. Of course, if downriver and upriver problems are not solved in the very near future and the public does not continue to support nor give the fishery profession the monies or the time to eliminate these roadblocks caused by man's uses of the water and the lands, then salmon and steelhead could perish from the SNRA. It appears at this time with major breakthroughs anticipated on reduction of nitrogen gas disease and better passage of downstream smolts that stocks will be increased. There will be some low critical years ahead until stocks start returning from the more enhanced conditions. Once the limiting factors have been buffered, the overall picture will look much brighter.

Summer Chinook

The summer chinook run in the Columbia, Snake, and Salmon Rivers is composed entirely of upriver origin and passes through the lower Columbia River from late May through July. This run moves into the SNRA mainly during late July and August and the first part of September. In the 1950's, the run reached maximum abundance with 207,000 fish in 1957. Since this time, there has been a general decline to a level of between 70,000 to 100,000 fish. However, the lowest recorded run of 53,000 fish occurred in 1945 due mainly to overharvest

by the commercial fishery. Since 1962, the run has stabilized at a level below 100,000 fish. One reason for the poor production is believed to be the deterioration of spawning and rearing areas in the Salmon River drainage in Idaho, including those in the SNRA.

In evaluating the downriver impacts effecting the fishery within the SNRA, Snake River dams may have been more severe than Columbia River dams above the confluence of the Snake River and may have caused more drastic declines in the Salmon River stocks than Columbia River stocks. The author believes the heavy degradation of summer chinook spawning areas by land use activities in the upper Salmon River drainage may have also been a major reason for more decrease in Salmon River stocks.

The summer chinook run was about 73,000 fish in 1970, the second smallest run since 1950. As stated before, production of this racial group has continued to be poor because of environmental problems. After the Indian fishery and other incidental commercial harvest, the 1970 escapement run out of the Bonneville pool was only 61,500 fish--the lowest since 1963 and much lower than the desired escapement of 80,000 to 100,000 fish. This escapement figure is needed in order to sustain a summer chinook salmon fishery within the SNRA and still have the needed escapement to spawn. In recent years, since 1965, summer chinook runs have been so low that most of the summer chinook seasons in Idaho and within the SNRA have been closed to protect the race.

Because the Salmon River produces about 41 percent of the summer chinook salmon that enter the Columbia River, and at one time was much higher than this, it is very important that the upstream environment utilized by this race be more carefully managed. If the constant degradation of their

upstream and downstream environment was stopped and the move towards enhancement gained, this race could again be a large contributor to the economy and recreation of Idaho and the Pacific Northwest.

During the last few years, the production rate for summer chinook has been lower than any other race of salmon in the Columbia River drainage and just holding its own. At present, each summer chinook spawner (male and female) produces only one returning adult to the spawning area; thus, there has not been an adequate surplus for a sport and commercial fishery. At one time, summer chinook provided one of the largest commercial yields.

Summer Steelhead

The upriver summer steelhead run enters the Columbia River from June through October. The early or Group A segment enters the Columbia River between June and mid-August. It is the largest run segment, and is composed of generally smaller fish. The late or Group B segment enters the river from mid-August through October. Group A fish overwinter in the lower and middle river, moving into the SNRA during April, May, and June. Both segments of the run have declined in recent years because of high losses to both upstream and downstream migrants passing mainstem Columbia and Snake River dams.

This fish is not heavily harvested in the SNRA area due to their late arrival in the upper river and the advent of high, turbid water in April and May. However, the spawning and rearing areas contribute to offsite fisheries. Anglers in 1970 caught 10,100 steelhead from the Main Salmon River almost all below the SNRA area. About 1 percent of the State harvest of steelhead are caught within the proposed SNRA.

During 1938-1963, the steelhead run size averaged 259,000 fish, but decreased during 1964-1970 to 180,000 fish, reflecting the decrease in the production and survival of juveniles in recent years. The run has fluctuated from a high of 422,800 in 1940 to a low of 138,000 in 1970.

Idaho waters produce approximately 55 percent of the Columbia River summer steelhead trout. Because many of the steelhead destined for the Salmon River spend the winter in the Snake and Columbia Rivers, they also offer an excellent fishery in downriver areas. These fish then enter the spawning areas such as those in the SNRA in the spring.

Sockeye Salmon

A small sockeye salmon run returns up the Salmon River each year to Redfish Lake. This run was considerably larger in past years, but due to man's influences is now barely hanging on. It contributes very little to the fishery in the SNRA and is in the endangered status within the area. There were once very large runs of sockeye into Redfish and Alturas Lakes. Stream migration blocks for irrigation purposes have probably helped eliminate sockeye runs from Alturas Lake. At one time, sockeye spawned and reared in Redfish, Alturas, Stanley, Pettit, and Yellowbelly Lakes. This species could be increased in the years to come as both downriver and upriver stresses are relieved. They could become a visitor's attraction for visual observation due to their bright color and spawning along lakeshores.

Lamprey

Lamprey runs have also declined due to the same conditions that affected the anadromous salmonoid runs. They utilize the SNRA and side tributaries to

spawn, rear, and as a transportation system to reach upstream and downstream spawning and rearing areas.

Because they are quite inconspicuous and inedible, they offer no input into the recreation resource. Because the adults do not feed on their upstream migration and the young are not piscivorous, they offer very little influence or concern to the sport fishery. This species of fish could die out in the study area without any concern of the users of the system.

Resident

The resident fishery is composed of more species, but does not draw the constant national attention that the anadromous salmonoid fishery does. However, it produces the bulk of the fishery and the majority of the fish creeled. In the resident fishery lies the major values.

Dolly Varden, a char, use the system quite extensively as an overwintering area moving to tributaries during certain periods of the year to rear and spawn. This fish is quite successful in both the streams and lakes and due to its ability to gain a large size in infertile waters, has some trophy value.

Rainbow trout due partly to artificial supplement are the most numerous fish entering the creel. Whitefish are probably more numerous but are not sought after by the fishermen. A winter fishery has developed between Sunbeam Dam and Clayton during winter periods. Cutthroat trout appear throughout the area but are harvested mainly in the high mountain lakes. Grayling are just being established and will in the future provide more diversity to the fishermen. California golden trout are lower in numbers than in past years, but are being introduced. They do have high trophy value.

Nongame Fish

Nongame fish, sometimes referred to as undesirable, forage, or trash fish, are present in the study area. Conditions within the environment allow squawfish, suckers, dace, and shiners to compete with salmonoids. The salmonoid fishery could benefit if nongame fish populations could be better controlled.

Summary

The SNRA plays a very important role in one of Idaho's more valuable fisheries. The value of this area as a fishery is very dependent on the influences in the downstream area, and, in turn, downstream areas are dependent on conditions in upriver environments.

The present goal of the Idaho Fish and Game Department in the anadromous fishery is to allow an adult escapement after the commercial and downriver sport fishery over Little Goose Dam of the necessary numbers to insure Idaho both a sport fishery and the necessary spawning escapement. If these escapement numbers can be maintained, it will provide a good fishery in the proposed SNRA, mainly on salmon.

These goals are being pretty well met on spring chinook and summer steelhead, but are failing on summer chinook. The following few years, until the nitrogen gas disease is controlled and better fish passage conditions gained, we could see all the species go below the goal of fish passage numbers. Conditions could become very critical and run size could drop to the level that many interests would likely request the end to fish passage. The potential magnitude of the runs could be significantly increased when present limiting problems are solved.

When these limiting factors become controlled and the artificial fisheries gain in numbers and contributions, the anadromous salmon and steelhead runs into the SNRA will greatly increase. It is possible that they may someday, in the near future, surpass historic runs.

FISHERY

An outstanding and interesting feature of the area, and constituting a unique biological feature, is the anadromous runs of chinook salmon and steelhead trout from the ocean up the Columbia, Snake, and Salmon Rivers. They enter the study area for reproducing and completion of their life cycle and the young rear to smolting size where they become a major visitors' attraction. These fish not only provide a local sport fishery, but also contribute greatly to the downriver sport and commercial fishery. The young from these spawning salmon will live to be of economic benefit--not only to our country but Japan, Russia, Canada, etc. --because they feed in ocean fishing areas off the coast and on up to the Aleutian Islands. Thus, they are contributors to Idaho, the Pacific Northwest, and other countries of the world.

The trout fishery in the lower elevation streams and upper elevation lakes is a very esthetic type of fishing. It has great demand because of the pristine type of experiences it has to offer. The past few years have seen an ever-increasing popularity and interest in the mountain lakes, particularly since the advent of trail cycles, better backpacking equipment, more time, and better access. As fishing pressure continues to increase, the resource managing agencies are faced with the problem of maintaining existing fish populations, plus expanding the productivity of the existing fisheries and placing other now barren waters into production.

The salmonoid species, which are the type of fish the recreationists are demanding, have developed to meet conditions of the glaciated and fluviogene environments. In fact, salmonoid races, like salmonoid species, have developed essentially through geographic isolation. This specific adaptation

for a particular environment, a product of evolution, is demonstrated by salmon, steelhead, and trout utilizing the lower stream systems. Salmon, steelhead, and trout have been on this world long enough to have lived through almost all of the fluviogenic landforms that now make the study area so outstanding and have patterned their life cycles to fit the present waterscapes. They have done quite well in this relatively high elevation area, and with man's understanding and manipulation can do even better.

The study area, because of its diversity, fulfills the many needs of the recreationist for fishery recreation. Salmon and steelhead fishing in the lower elevation areas, in combination with trout fishing in the high mountain lakes and small streams, sets this area apart from most other areas as far as desirability from a fishing standpoint.

The present management of the fishery lies totally within the authority and jurisdiction of the Idaho Fish and Game Department. Setting fishing regulations and fish stocking are their responsibility. The management of the aquatic environment is the responsibility of the U. S. Forest Service. It is highly desirable and necessary to have complete cooperation and working relationships between the Idaho Fish and Game Department and the U. S. Forest Service if the aquatic environment is to produce to its fullest potential the resulting fishery resource.

At present, the majority of the lakes are not accessible for stocking with land motorized fish stocking equipment. As a result, the Idaho Fish and Game Department does the needed stocking mainly with the use of helicopters and fixed-wing airplanes. The first aerial fish stocking in the area was made in 1919. At present, these methods of stocking have provided excellent

fishing for the number of fishermen entering the proposed SNRA. An attempt is made to stock some of the more heavily fished lower elevation lakes and streams every year. Many of the higher elevation lakes are stocked every 3 years. Higher elevation streams are mainly stocked through natural reproduction.

Many of the streams and some of the lakes have vehicle access and are stocked with use of this transportation system by the Idaho Fish and Game Department. Other streams (with and without vehicle access) are capable of producing their own fish population to meet present fishing pressure.

Fish cultural activities carried on by the Idaho Fish and Game Department include fish stocking, and chinook salmon and steelhead spawn taking. Studies conducted in 1959 showed that 38 percent of the fish take was composed of hatchery-reared fish. Stocked trout accounted for approximately 75 percent of the harvest at Stanley, Alturas, and Redfish Lakes.

Other projects carried on by the Idaho Fish and Game Department include: fish species composition control, weir construction, high mountain lake surveys, trail construction, and creel census. Rough fish eradication projects have been completed at Pettit, Stanley, Yellowbelly, and Hell Roaring Lakes, and some fish barriers installed.

Past Fishery

Anadromous fish have been eliminated from the Boise and Payette Rivers by dams constructed about 1920. Salmon and steelhead still gain access to the SNRA via the Salmon River, but at much less reduced stocks than in past years. Artificial stocking has helped to increase the value of the fishery and fishing success, but, undoubtedly, the fishery was of much more magnitude in earlier years than it is now.

In the past, there were many maneuvers taken to attempt to enhance the fishery. Some were beneficial, but some were not. In the early 1920's, large numbers and varieties of exotic fishes were stocked in the area in an attempt to increase fishing desirability and success. Lakes like Alturas, Sawtooth, and Redfish were stocked indiscriminately. Alturas Lake, in the 1920's, was stocked with rainbow, brook trout, landlock salmon, grayling, kokanee, and smelt. At this time, sunapee golden trout were also being stocked in many of the lakes. Smelt (with the use of eggs) were distributed in both the lowland lakes and some of the higher lakes. These evidently failed, although the author did observe and catch smelt in Sawtooth Lake in 1946.

Present Fishery

In the higher elevations, snow and ice leave slowly in the spring and return early in the fall. The annual discharge pattern of the main river and streams is very regular and characteristic of snow-fed streams in the Pacific Northwest. High flows occur from April through July. Chinook salmon use these higher flows to reach the area, and the young smolts use these flows to help them reach the ocean. Low flows occur from August through March.

The fishing success or desirability is determined to a large extent by stream condition. During high flows, the streams are sometimes inaccessible and velocities usually make fishing success very low and undesirable. During normal base flows, fishing conditions are much more optimum. Usually, by mid-July, good fishing conditions have developed which last until freezeup in October or November. The short, ice-free conditions make the available fishing

period very short in the majority of the area. A fundamental characteristic of high elevation waters is the relatively short summer season while over the rest of the year generally severe conditions prevail with low temperatures, floods, ice, and snow. Snowslides or long periods of deep snow cover can completely kill out a fish population in small streams, shallower lakes, and, on some occasions, in deeper lakes--thus making the lake or stream barren. A well-populated lake one year may be a desert the next year as far as fish life is concerned.

Climatic conditions vary from year to year so that there is great variability in the processes acting upon the environment. Some shallow lakes are marginal and may support fish for several years until a severe winter depletes the oxygen supply or displaces the water. However, many lakes with depths of only 4 to 5 feet in depth are able to support continuous fishing, as they have constant inflow, seepage, or upwelling. Thus, the fishing of the high country can be a guessing game to the fishermen due to climatic influences. Also, many of the lakes and streams have not been studied or managed to the point that fisheries can be determined, predicted, or governed.

Anadromous fish destined for the study area have to pass over seven dams at the present time. The young migrating out of the study area also have to pass over or through these dams to reach the ocean-rearing areas. Approximately 98 percent of the chinook harvest in Idaho is annually taken from the Salmon River drainage. The main stem of the Salmon River annually produces about 50 percent of the State chinook salmon harvest. Idaho waters produce approximately 55 percent of the Columbia River summer steelhead trout, which

are found throughout the Salmon River drainage. It can be easily determined that as the aquatic environment goes in the SNRA and the lower Salmon River, so goes the State's anadromous fishery. It is imperative that this environment be maintained and some of the degraded conditions enhanced.

Detrimental aquatic environment conditions seem to be accentuated in the more downstream areas of the Salmon River. For example, formerly much of the main stem Salmon River and its tributaries may have been suitable as juvenile rearing areas. At present, few salmon and trout are observed downstream from Challis, Idaho. Very seldom are rearing salmon and steelhead juveniles found. Tributaries have been dewatered and water temperatures and sediment accruement of the main stem increased due mainly to irrigation diversions and irrigation return flows. Thus, the upstream area within the SNRA is of extreme importance for the rearing of young salmon and steelhead.

The Salmon River runs for about 50 miles through the study area and portions are open to salmon, steelhead, and trout fishing during certain periods of the year. The trout season extends from about May 30 to November 30. During 1972, steelhead fishing will be completely closed above the mouth of Redfish Lake Creek on the Salmon River. The Lower River will close (within SNRA) April 10. The bag limit on steelhead will be two per day and salmon will be one. A season limit of five on salmon and ten on steelhead will be in effect. The salmon season will close after July 15 above Redfish Lake Creek and will close July 31 in the Lower River. The fishing for salmon will be completely closed above Hell Roaring Creek on the Main Salmon River.

Table 2 Chinook salmon redds counted in the SNRA in Alturas Creek, Salmon River above Clayton, Valley Creek, and the East Fork Salmon River above Big Boulder Creek.

Stream	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Alturas Lake Creek	33	30	138	86	80	101	119	74	110	41	68	50
*Salmon River	1,471*	1,133*	638	638	706	472	699	943	637	313	432	619
Valley Creek	224	389	272	191	270	261	403	332	393	57	243	236
**East Fork Salmon River	-	618	334	646	405	138	511	614	622	174	468	370
***Salmon River	818	356	465	195	415	201	390	365	223	120	150	220
Drainage totals	9,472	9,581	8,592	7,287	8,193	4,289	7,127	7,444	6,531	3,962	4,442	3,883

*Salmon River above confluence Valley Creek

**East Fork Salmon River above Big Boulder Creek

***Salmon River above Clayton to Valley Creek

Future Fishery

The fishing pressure in the study area is increasing at a very rapid rate. In fact, it is increasing so rapidly that the needed increased management of this area, as related to the fishery resource, has not kept step. The numbers of fishermen nationally predicted by the Columbia-Pacific Region Study will increase 165 percent by the year 2000. Fishing pressure nationally by 2000 will be over three times what it was in 1960. Because of the high desirability of the study area for fishing, it is very likely that these waters will receive a much greater expansion than that predicted nationally.

These "last frontiers" will continue not only to bring more local recreationists into the area, but with the constantly improved transportation, more leisure time, more interest, and a greater influx of out-of-State fishermen, the study area is bound to be more heavily used.

Many recreationists may just enjoy seeing cutthroat trout swimming in a crystal clear high elevation tarn lake, or observe brook trout rising in a beaver dam located in a high basin meadow, or watch salmon spawning on a gravel bar in the lower river area, or witness steelhead trout work their way up a small tributary. This is not direct participation or a consumptive use of the fishery, but, because of its importance, must be considered in the overall use of the aquatic environment. In some areas during certain time periods, it may be of more value than the actual fishery.

Steadily increasing fishing pressure will probably necessitate the stocking of more waters within the area with larger numbers of catchable and fingerling trout. Presently 32,000 catchable size rainbow trout are being

stocked annually in Redfish Lake. Motorized vehicle access to needed water areas for fish stocking vehicles will need to be considered and probably increased. Stocking needs to be done efficiently to enable the highest return to the creel.

The SNRA offers an opportunity to increase the range of endangered or rare species. The grayling native fluvial cutthroat and California golden trout are examples of fish that could possibly be increased. The Idaho Fish and Game Department has already taken strides in this direction. The California golden trout provides considerable novelty demand and is a trophy fish to many of the recreationists. The environment of the summer chinook, which utilizes the lower portion of the Salmon River found within the area and Valley Creek, needs careful management, as this race is close to passing out of the picture and becoming a rare race or even an endangered race. Aquatic environment conditions in summer chinook spawning areas are especially critical to its survival.

Stocking of species not already found within the area should be scrutinized very closely. The indiscriminate stocking of the 1920's and 1930's should not be allowed to again come into management programs.

There will undoubtedly be changes in the recreationist's attitude and demands on the fishery during coming years. This will place emphasis on more intensive management to provide such things as:

1. Preservation of natural environments and wild and native fish stocks.
2. Trophy trout, salmon, and steelhead.
3. Catch and release.
4. Increased stocking and development of artificial runs of salmon and steelhead.

5. Visual observation of certain fish life cycle stages.
6. Possible increase of surface waters.
7. Stream and lake enhancement.
8. Minimum stream flows and lake levels.

Management programs will need to be geared and directed to meet these needs.

Artificial Fishery

Due to degraded conditions (Table 2) in both the upriver and downriver aquatic environment, it has been necessary to attempt to supplement the natural anadromous salmon and steelhead runs. Major streams and the main river are also supplemented with hatchery reared trout.

The success of the Rapid River spring chinook hatchery on a tributary of the Little Salmon River provides some measure of increases in run size that may be possible in the future. The returns to Rapid River in 1970 (as a result of release of 1½ million smolts) provided a 22.9 percent increase in the Salmon River spring chinook run. It is possible that this hatchery alone could cause an increase of 40 percent in spring chinook runs into the Salmon River. Two or three hatcheries of similar capacity and success in the SNRA could produce great increases in spring salmon chinook or a total combined increase of approximately 180 percent. It is very possible the magnitude of the annual runs could be greatly expanded when downriver limiting stresses are released.

The Decker Flat rearing pond located just above the confluence of Redfish Lake Creek on the Main Salmon River is attempting to establish artificial spring chinook runs by releasing pond-reared smolts. It is too early to determine the success or failure of these experimental projects.

STUDY AREAS

Salmon River Valley*

The Salmon River is one of the few rivers remaining that is unused as a water storage system. It does, however, have many water diversions due to constant diversion for irrigation, that, in turn, is degrading the aquatic environment. It also has considerable influence from road construction, especially from Stanley to Clayton. Under present conditions, this river is not capable of its potential resource use as a fishery. The need for this river and other streams to produce more to the fishery plus the possible need for additional water areas will continue to increase as more and more demand is placed on the fishery resource.

The fish species composition within some of the heavier used fishing areas contains nongame fish which are not in demand by the recreationist. An area or segment of the aquatic environment is only capable of carrying and producing a certain amount of fish. When a significant portion of the existing fish production is an undesirable product, the resource suffers because of the dampening effects on the desirable fish species. There is a real need for the continuing fish species population control by the Idaho Fish and Game Department.

The main Salmon River and some of the major tributaries have been studied quite intensively for physical and hydrochemical conditions. These studies have been instrumental in pointingout some of the limiting factors effecting the aquatic environment.

*This breakdown of land area corresponds very closely with the depositional land type.

Photograph 1. Almost complete diversion on the Upper Salmon River diversion (located T. 7 N., R. 14 E., Sec. 3) which is very degrading to salmon, steelhead, and trout plus a float or canoe type recreation.

Photograph 2. The same diversion location as above only with natural flows.

Photograph 3. Almost complete diversion during salmon spawning periods on Alturas Creek diversion (located T. 7 N., R. 14 E., Sec. 4). A complete fish migration block.

Photograph 4. The same diversion location as above only with natural flows.

Table 3 A summary and average of physical aquatic environment survey information for the Salmon River from its confluence with Redfish Lake Creek upstream to the headwaters.

Stream (Feet)			Pool		Streambed Surface Composition (Percent)				Banks		
Width	Depth	Riffle	Width	Rating	Boulder	Rubble	Gravel	Fines	Cover	Cond.	Type
61	13.5	47	14	3.4	23	63	10	04	1.4	1.7	1.3

The main river is in almost excellent condition as far as streambed materials. The 4 percent fines is probably quite close to natural conditions, and resource activities to date have had little effect on this physical condition. The river is mainly a rubble environment and low in gravels. However, there is sufficient gravel for the spawning populations of salmon and steelhead.

Streambank cover, condition, and type are good. Lack of vegetative cover plus damage from livestock grazing keep the streambank from having an excellent rating. The main river is lacking in pools which is a natural condition. Because the river is so important in raising salmon and steelhead to smolting size, the predominance of food-producing area and the numerous low quality pools have their purpose. A pool rating of 3.4 is quite low; however, we tend to rate these more to the hatchery product and not to just what the overall fishery needs. Low quality streamside pools play an important part in the development of a smolt or other young salmonoids.

Under the present water management plans, both upstream and downstream salmon, steelhead, and trout are faced with movement restriction, migration blocks, and loss of desirable habitat. Water diversions within the SNRA

(some total diversions) are very critical due to already low flows because incoming tributary waters have not had a chance to add much flow.

These diversions exist on both private and public lands and are used for irrigation purposes from about July 1 through about September 15. The irrigation season coincides with part of the period of low water flows, so that it is necessary on certain diversions to divert the whole river or streamflow in order to provide enough water for irrigation. It would cost an estimated $135,000 to install proper screening devices. The irrigation season (and subsequent stream diversion) coincides with the upriver migration of anadromous salmonoids to their spawning locations and during their spawning periods.

Photograph 5. The same water diversion shown in photograph 3 and 4. This photo was taken the same day as photograph 3 and demonstrates the amount and percentage of flows being diverted to the pasturelands.

Photograph 6. Waters being diverted to the pasturelands. Due to being unscreened, the young salmon, steelhead, and trout are left in the fields.

Photograph 7. Blowout caused by water diversion breakout in canal taking water from the stream to the pasturelands.

Table 4 Location of temperature and hydrochemistry stations in the Salmon River and tributaries within the SNRA.

Teamperature Stations	Location	Hydrochemistry Stations
Station 1T	Upper Salmon River at Highway 93 bridge	Station 1H
Station 2AT	Above Alturas Lake Creek diversions	
Station 2BT	Below Alturas Lake Creek diversions	
Station 3AT	Above Upper Salmon River diversion	Station 2H
Station 3BT	Below Upper Salmon River diversion	
Station 4T	Mouth of Alturas Lake Creek	Station 3H
	Salmon River Highway 93 bridge near mouth of Alturas Lake Creek	Station 4H
Station 5AT	Above Decker Flat diversion - Salmon River	
Station 5BT	Below Decker Flat diversion	
Station 6T	Mouth of Redfish Lake Creek	Station 5H
Station 7T	Valley Creek (Motel Bridge)	

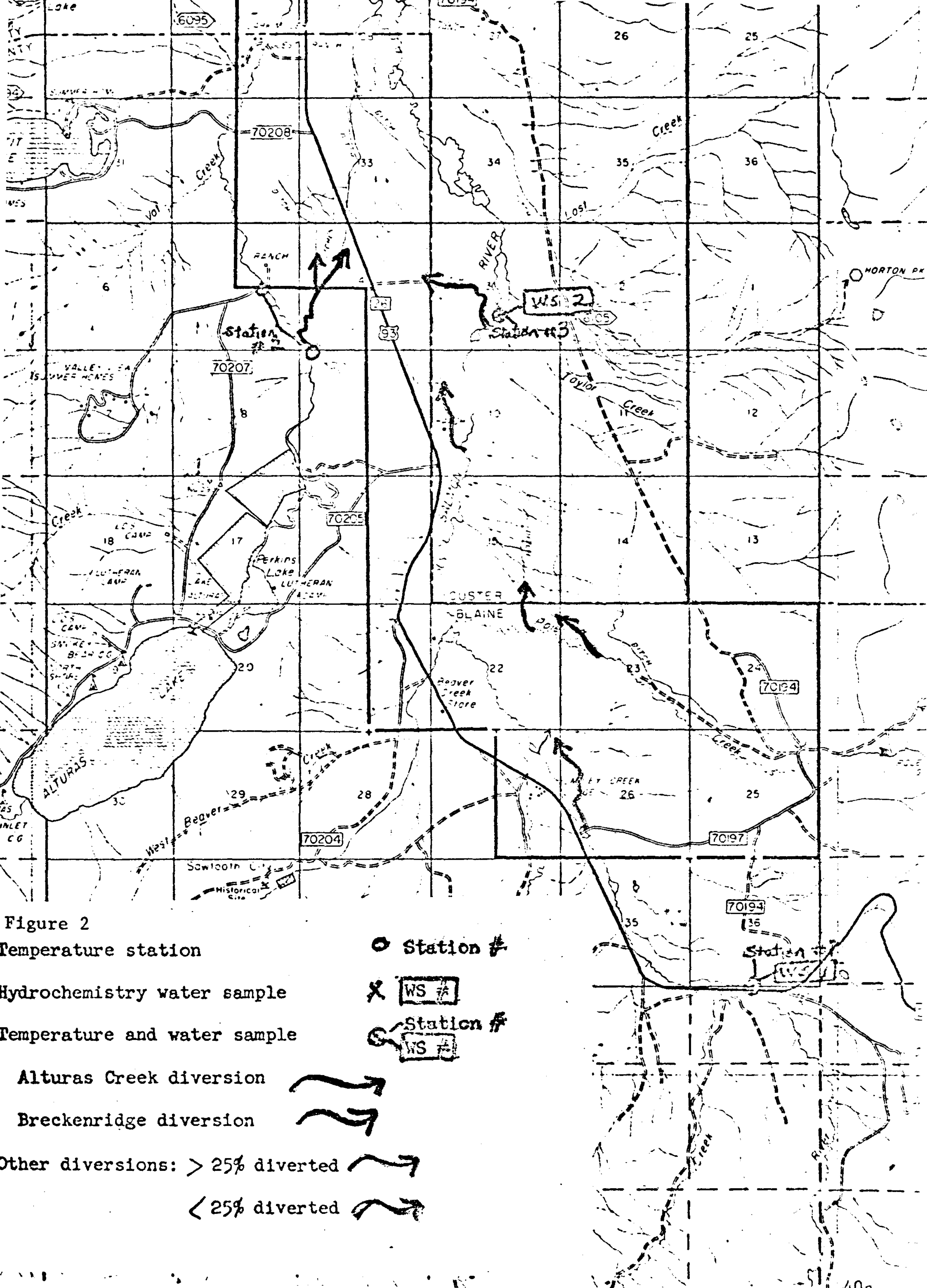


Figure 2

Temperature station — Station #

Hydrochemistry water sample — WS #

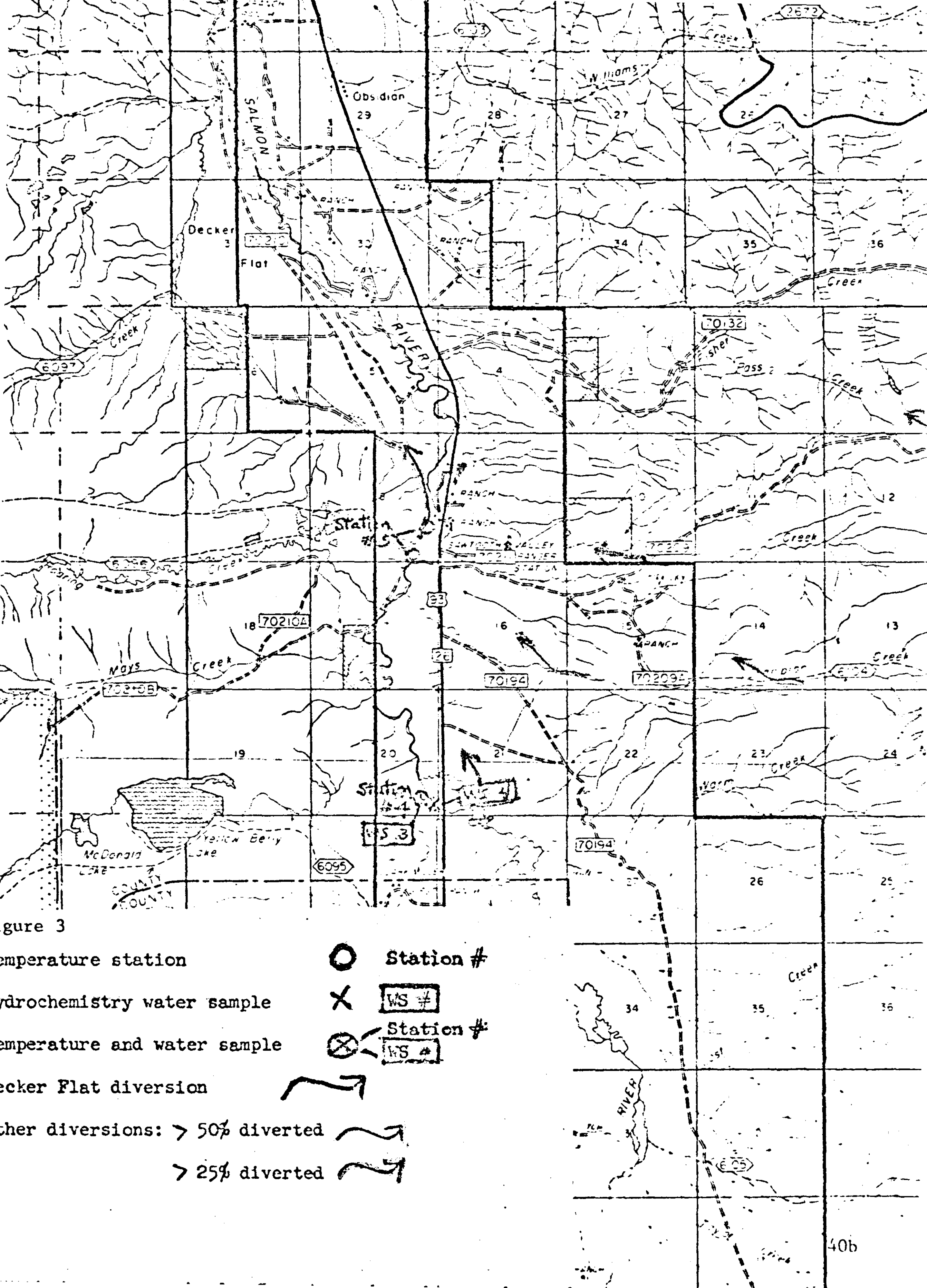
Temperature and water sample — Station # WS #

Alturas Creek diversion

Breckenridge diversion

Other diversions: > 25% diverted

< 25% diverted



Obsidian
SALMON
RIVER
Decker
Flat
Williams
Station #5
Station #4
WS 4
WS 3
Mays
Creek
Yellow Belly Lake
McDonald Lake
Pass
Warm
93
26
70194
6095
6097
702104
702098
70132
70209A
igure 3
emperature station
ydrochemistry water sample
emperature and water sample
ecker Flat diversion
ther diversions: > 50% diverted
> 25% diverted
Station #
WS #
Station #
WS #

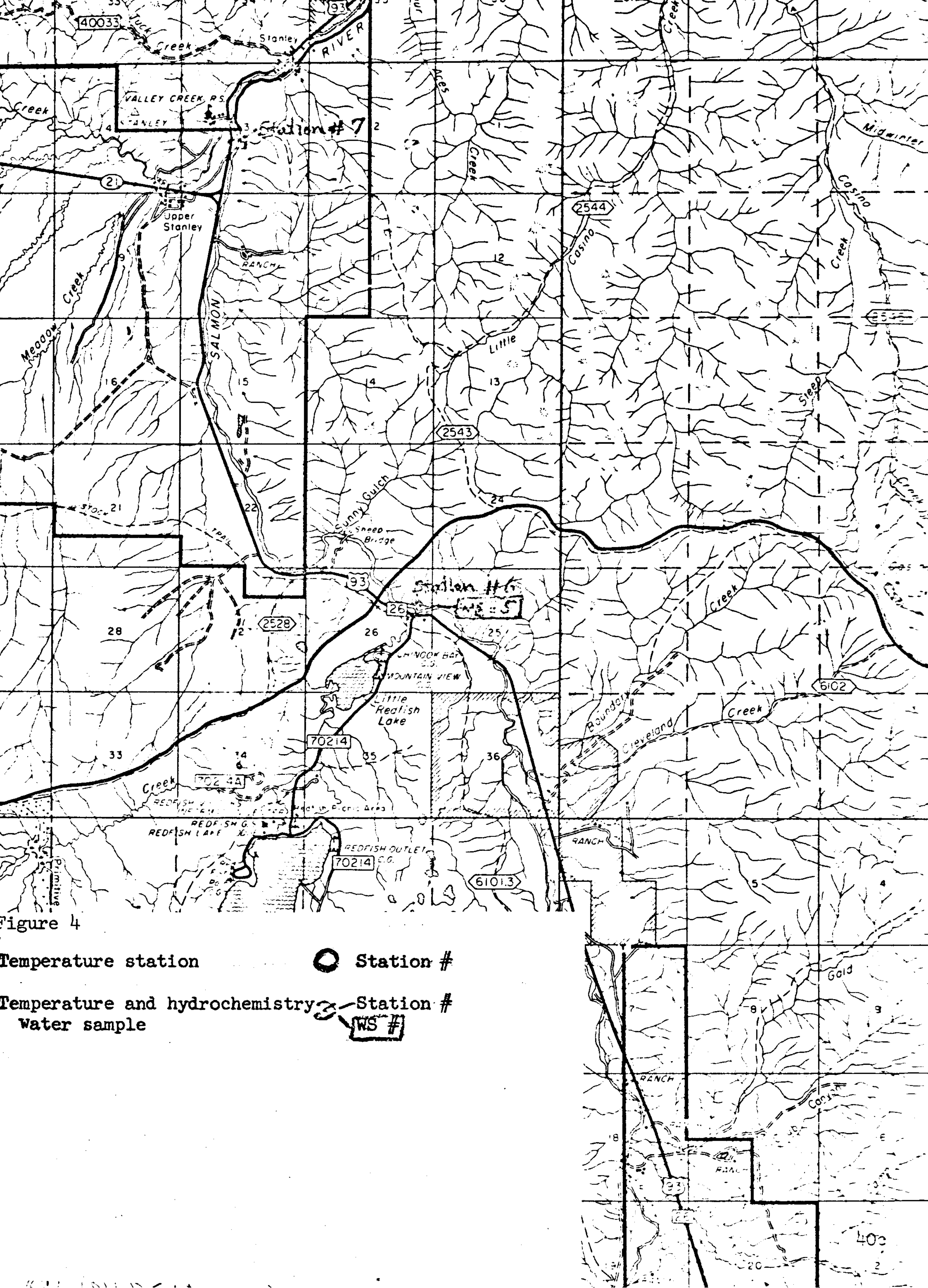


Figure 4

Temperature station — Station #

Temperature and hydrochemistry Water sample — Station # / WS #

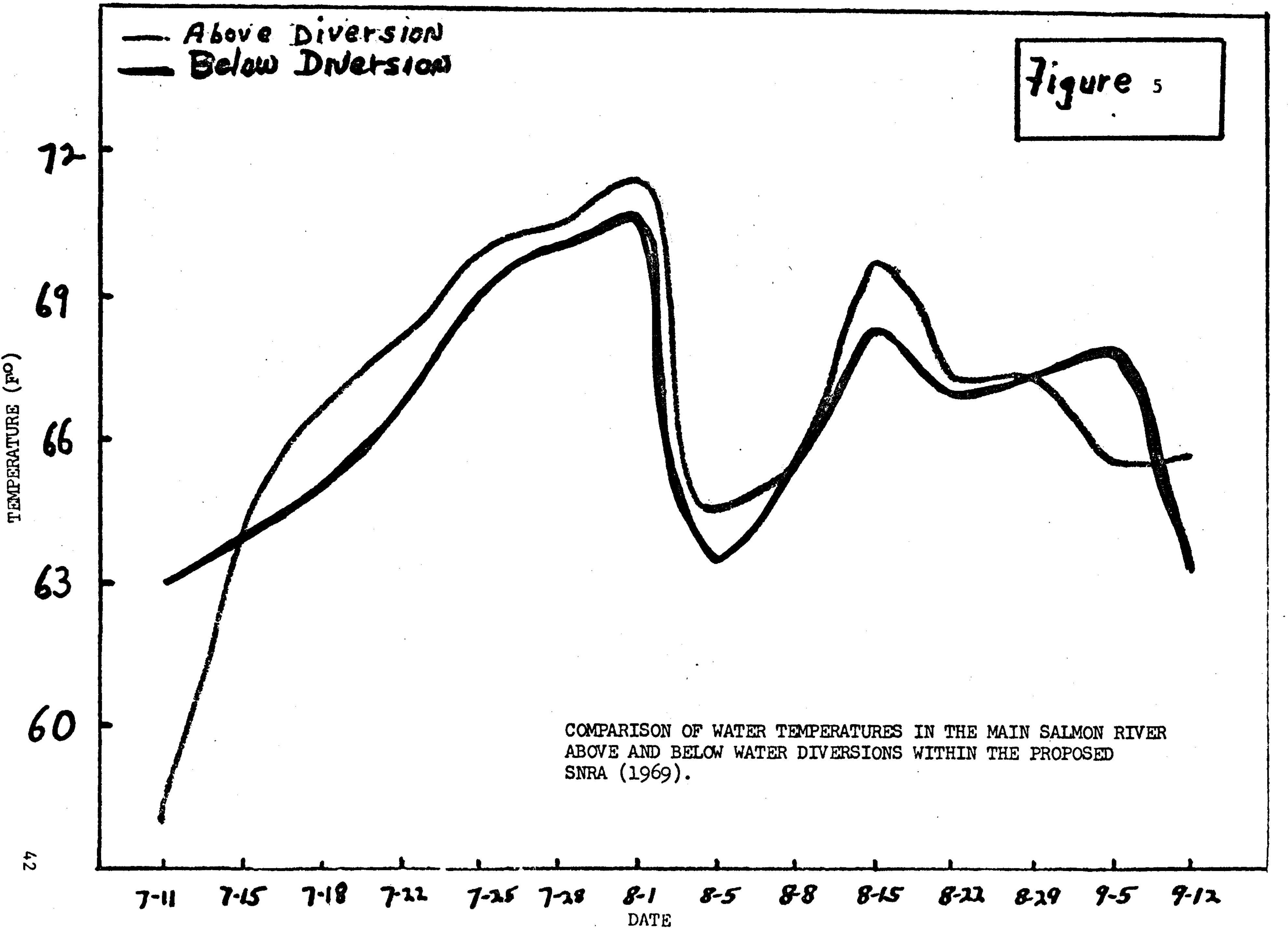
Table 5 Comparison of water temperatures in the Main Salmon River above and below water diversions* within the proposed SNRA, 1969.

DATE	7-11	7-15	7-18	7-22	7-25	7-28
Average						
Above	58	64	66.6	68.0	70	70.5
Below	63	64	65.0	66.3	69	70.0

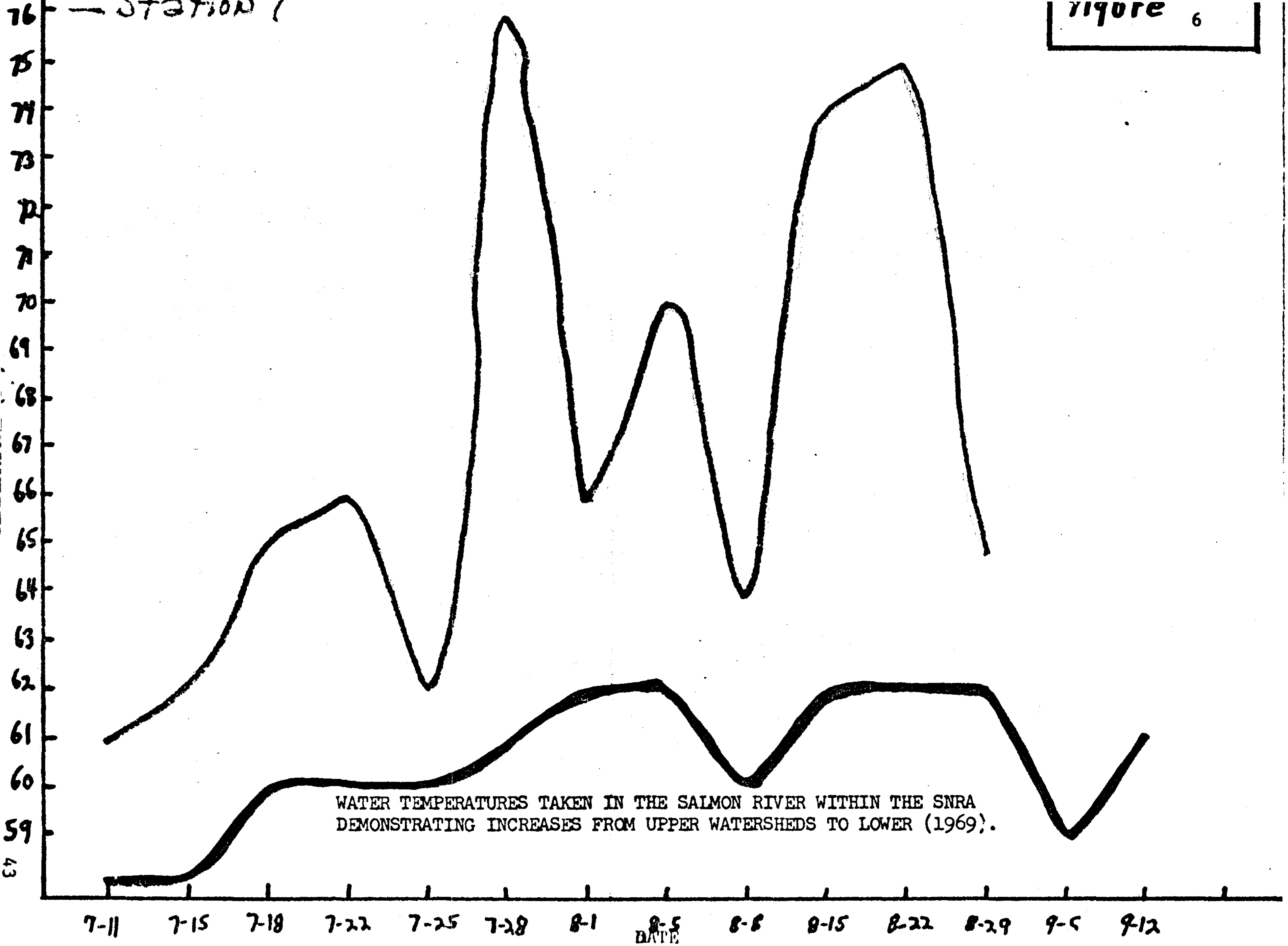
DATE	8-1	8-5	8-8	8-15	8-22	8-29
Average						
Above	71.5	64.5	65.3	69.6	67.3	67.3
Below	70.7	63.5	65.3	68.3	67.0	67.3

DATE	9-5	9-12
Average		
Above	65.5	65.6
Below	68.0	63.3

*Composed of Alturas, Breckenridge, and Decker Flat diversions



COMPARISON OF WATER TEMPERATURES IN THE MAIN SALMON RIVER ABOVE AND BELOW WATER DIVERSIONS WITHIN THE PROPOSED SNRA (1969).



WATER TEMPERATURES TAKEN IN THE SALMON RIVER WITHIN THE SNRA DEMONSTRATING INCREASES FROM UPPER WATERSHEDS TO LOWER (1969).

Thermal Conditions

The author felt that possibly water diversions could have adverse effects on the aquatic environment by increasing water temperatures both onsite and offsite. To analyze this thinking, three diversions were monitored with maximum-minimum thermometers at the following diversions:

Station 2	Alturas Creek diversion
Station 3	Upper Salmon River diversion
Station 5	Decker Flat diversion

The studies pointed out that the diversions did not increase water temperatures onsite. Decreased waterflows on offsite areas could result in increased water temperatures due to decrease in volume. The very low flows below diversions, which in the Alturas and Upper Salmon River diversions, were almost completely dependent on subsurface inflows and some side tributary accruement, were slightly cooler. There was not enough difference above and below diversions to be typed as either beneficial or detrimental. It would take further study downriver to determine offsite temperature effects. Figure 6 does demonstrate that there is large increase in water temperature as the water moves through the system. Whether water diversion has any effect on this increase is not known.

Alturas Lake Creek at the diversion (Station 2) was the warmest of the stations monitored. This demonstrates the effects of the warming of surface waters of Alturas Lake which are evidently skimmed off at the outlet by the stream. By the time waters reach the mouth of Alturas Creek, they have dropped in temperature due to shading, air temperatures, and loss of heat to basin. Waters at the mouth are as cool or cooler than the main Salmon River waters.

Table 6 Maximum-minimum water temperature results for the Salmon River in the Proposed Sawtooth National Recreation Area. Data collected July 11 through September 12, 1969 (^{o}F.).

		7/11/69		7/15/69		7/18/69		7/22/69		7/25/69		7/28/69		8/1/69		8/5/69		8/8/69		8/15/69		8/22/69		8/29/69		9/5/69		9/12/69	
Station		max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
1. Upper Salmon/ Bridge Highway 93		58	42	58	41	60	40	60	40	60	40	61	41	62	40	62	44	60	38	62	40	62	40	62	40	59	38	61	36
2. Alturas Creek Diversion	above	58	51	70	56	72	55	74	55	76	57	76	56	79	55	77	53	74	51	78	52	75	51	74	50	70	44	70	42
	below	68	53	66		69		72		77	54	78	51	80	50			75	50	79	50	78	48	78	47	73	41	70	41
3. Breckenridge Diversion	above	58	42	60	56	63	42	64	42	65	42	65	42	67	40	64	40	61	38	66	40	64	40	64	38	61	35	61	34
	below	58	40	60	43	61	43	62	44	62	44	62	44	64	46	62	43	59	42	62	42	61	41	62	40	60	36	61	36
4. Mouth of Alturas Creek		56	48	67	52	66	52	61	47	70	50	64	49	65	48	64	47	60	47	63	46	61	46	62	47	60	42	58	42
5. Decker Flat Diversion	above			62	54	65	50	65	50	69	50		48	69	48	65	46	61	45	65	46	63	46	64	44		41	66	40
	below	64	55	65	49	65	48	65	55	67	47	66	46	68	46	65	45	62	43	64	44	62	44	62	42	60	39	59	41
6. Mouth of Redfish Lake Creek		63	51	63	58	65	59	65	61	67	62	68	63	69	64	70	62	68	61	68	61	67	61	68	60	66	55	62	54
7. Valley Creek		61	61	62	53	64	60	66	56	62	52	76	62	66	56	70	65	64	58	74	62	75	54	65	52				

Table 7 Hydrochemistry averages for seven different dates of collection at each station obtained from Table 2.

	Alk	T.S.	T.D.S.	Fe	Cu	NO_3	PO_4	Pb*	Zn*	Turb*	Hard*
Station 1.	44.6	139.4	125.7	.036	<.01	<.01	<.01	<.01	<.01	<25	84.0
Station 2.	42.2	144.0	128.1	.040	<.01	<.01	<.01	<.01	<.01	<25	100.0
Station 3.	42.2	128.6	124.4	.034	<.01	<.01	<.01	<.01	<.01	<25	89.3
Station 4.	45.1	155.4	138.1	.054	<.01	<.01	<.01	<.01	<.01	<25	92.0
Station 5.	31.4	98.3	88.6	.063	<.01	<.01	<.01	<.01	<.01	<25	64.0
Grand Average	41.1	133.1	120.9	.046	<.01	<.01	<.01	<.01	<.01	<25	85.8

*Averages obtained from only three dates of collection.

Table 8 Hydrochemistry analysis results for Salmon River in tributaries within the Proposed Sawtooth National Recreation Area.

A. Alkalinity

Station	7/11	7/18	7/25	8/1	8/8	8/15	8/25	Ave.
1	24	56	40	48	48	40	56	45
2	32	32	40	40	56	44	52	42
3	44	32	36	44	44	48	48	36
4	36	48	40	44	60	44	44	45
5	32	24	28	56	28	20	32	31
Average	34	38	37	46	47	39	46	*
				*Grand Average				41

B. Total Solids

Station	7/11	7/18	7/25	8/1	8/8	8/15	8/25	Ave.
1	164	192	204	100	104	104	108	139
2	160	200	208	104	112	112	112	144
3	188	188	184	92	100	124	124	143
4	204	204	212	120	144	100	104	155
5	152	148	144	64	64	56	60	98
Average	174	186	190	96	105	99	102	*
					*Grand Average			136

C. Total Dissolved Solids

Station	7/11	7/18	7/25	8/1	8/8	8/15	8/25	Ave.
1	157	170	170	92	95	95	101	126
2	152	170	168	98	102	102	105	128
3	157	152	163	84	92	111	112	124
4	182	180	186	109	125	90	95	139
5	136	133	126	62	61	48	54	89
Average	157	161	163	89	95	89	93	*
				*Grand Average				121

D. Fe (Iron)

Station	7/11	7/18	7/25	8/1	8/8	8/15	8/25	Ave.
1	.01	.01	.02	.01	.05	.07	.09	.04
2	.01	.01	.01	.03	.02	.09	.14	.04
3	.01	.02	.01	.01	.02	.06	.12	.04
4	.03	.01	.01	.08	.01	.17	.10	.06
5	.05	.02	.06	.06	.02	.12	.11	.06
Average	.02	.01	.02	.04	.02	.10	.11	*
					*Grand Average			.05

E. Cu (Copper); NO_3 (Nitrates); PO_4 (Phosphates)

Station	7/11	7/18	7/25	8/1	8/8	8/15	8/25	Ave.
1	.01	.01	.01	.01	.01	.01	.01	.01
2	.01	.01	.01	.01	.01	.01	.01	.01
3	.01	.01	.01	.01	.01	.01	.01	.01
4	.01	.01	.01	.01	.01	.01	.01	.01
5	.01	.01	.01	.01	.01	.01	.01	.01
Average	.01	.01	.01	.01	.01	.01	.01	*
				*Grand Average				.01

F. Hardness

Station	7/11	7/18	7/25	Ave.
1	72	88	92	84
2	100	92	108	100
3	112	80	76	89
4	100	80	96	92
5	64	56	72	64
Average	90	79	89	*
	*Grand Average			86

G. Turbidity (Ju)

Station	7/11	7/18	7/25	Ave.
1	25	25	25	25
2	25	25	25	25
3	25	25	25	25
4	25	25	25	25
5	25	25	25	25
Average	25	25	25	*
	*Grand Average			25

H. Pb (Lead); Zn (Zinc)

Station	7/11	7/18	7/25	Ave.
1	.01	.01	.01	.01
2	.01	.01	.01	.01
3	.01	.01	.01	.01
4	.01	.01	.01	.01
5	.01	.01	.01	.01
Average	.01	.01	.01	*
	*Grand Average			.01

Hydrochemistry

Hydrochemistry fluctuated both with changes in location and with changes in time, especially in the analysis of alkalinity, hardness, total solids, total dissolved solids, and Fe. (See Table 7 and 8.)

The concentrations of Cu, NO_3, PO_4, Pb, Zn, and turbidity were rather low and remained quite constant. The concentrations of total solids and total dissolved solids dropped off sharply between 7/25 and 8/1, which corresponds with decreasing waterflows.

The river, which reflects the lakes and streams which drain into it, is a low fertility environment. These streams are low in organic energy, although fairly high in kinetic energy. Total solids only averaged 136 p.p.m., total dissolved solids 121 p.p.m., alkalinity 41 p.p.m., iron .05 p.p.m., lead $<$.01 p.p.m., zinc $<$.01 p.p.m., copper $<$.01 p.p.m., turbidity $<$25 units, and low phosphate and nitrates.

Alkalinity

Carbonates, hydroxides, borates, and silicates are low within the system. This is undoubtedly due to the low soluble content of these elements within the mainly granitic watershed and due to the still low amount of sewage or mining wastes. This measure gives us an index to follow to determine if any buildup of land uses alters the hydrochemical portion of the aquatic environment within the SNRA. The low alkalinity is also reflected in the near neutral pH ratings. It also demonstrates that the tributaries are not causing any overfertility problems in the Upper Salmon River at the present time. (See nitrates and phosphates.)

The low alkalinity readings mean the system has low antagonistic action toward potential pollution sources. It would have little effect buffering buildup of heavy metals.

It would be beneficial to the aquatic environment (onsite) if alkalinity were doubled which would in turn raise pH. However, for the proper mix needed in offsite environments, it probably serves as a valuable dilutant by being on the infertile side. The low readings are natural in immature systems and probably result in better salmon, steelhead, and trout spawning success by keeping competition and other mortality factors down.

Total Solids

Total solids are low as would be expected in infertile waters. As the hydrologic curve decreases from June through September, the amount of total solids decreases. The low ratings not only demonstrate a lack of chemicals for the biotic environment, but also point out the low suspended sediment load being transported by the river. Most of the sediment load being transported by the system is bedload.

Total Dissolved Solids

Total dissolved solids are very close to the total solids showing that most of the additions being carried by the stream are in the dissolved form. This, plus the low readings is what results in the very clear waters found in the streams and lakes. Again, suspended sediment (organic and inorganic) is very minor and shows the pristine conditions of the water.

Iron

Iron is a good indicator of industrial mining or milling activity within a drainage. Iron is extremely low, building up (still at low levels) only

during the latter part of the year during low flows. When the specific iron salts are added to the system in these low quantities, the stream kicks it out of the system before ions can combine with hydroxyl ions and form precipitates, as we see in some other drainages in the Salmon River system.

Copper

Copper is also an indicator element and was not found within the drainage in any significant degree. This deadly ion will probably never be a threat to this environment, as it is probably very low in content within the watershed.

Nitrates and Phosphates

Nitrates and phosphates are indicators, along with other trace elements, to fertility. Within this study area, they are very low. The biotic environment is probably controlled by these two limiting factors along with other trace elements. Nitrates appear extremely low, but this is only a measure of (NO_3) and should not be confused with the three different types of analysis for nitrogen.

Hardness

The low hardness readings again point out the lack of calcium and magnesium ions, some of the basic building stones in the lower beginnings of the food chain. The low readings also again point out the low buffering effect this water has on potential pollutants.

Turbidity

Detailed turbidity measurements were not made. The equipment used was only accurate to 25 Jackson units. At no time did any sample show a turbidity of

Table 9 Flow results at three diversions on the Salmon River within the Proposed SNRA. (Date collected July 3, 1969, and September 10, 1969).

Station	Diversion Name	Comments	Diversion Stage	Discharge (c.f.s.) Above Diversion	Discharge (c.f.s.) Into Diversion	Discharge (c.f.s.) Below Diversion	Diversion Capacity (c.f.s.)	Approximate Time Span Diverted (Months)	Approximate Dry Stream Channel Length (Miles)
2	Alturas Creek	Has cement structure; halts migration to Alturas Lake during irrigation season (photo 1)	Incomplete	24.1	(20)	(4)			
			100% diversion	12	11	0.8	20	2½	1½
3	Upper Salmon River	Has cement structure; halts migration up main Salmon River (photo 2)	50% diversion	110	54	56			
			100% diversion	29	29	0	50	3	½
5	Decker Flat	No facilities for complete diversion. Has channel screen on irrigation channel and fishery bypass	Incomplete	-	-	-	25-35	2½	0

over 25 units, again demonstrating the clearness of the water and lack of foreign materials.

Lead and Zinc

Lead and zinc are other indicators of pollution and both were found to be extremely low. All data collected demonstrates the almost pristine condition of the water and its quality available for its inputs into the aquatic environment. Hydrochemically, there is no element that due to its overconcentration is exerting a limiting factor on the ability of the aquatic environment to produce a fisheries. There are some underconcentrations that are causing limiting factors, but these are undoubtedly needed to control the environment both onsite and offsite so it produces a desirable product.

Streamflows

The Salmon River has continuous water diversions which are altering the system. The most drastic diversions from effect on fisheries are found within the SNRA. The rate of flow was found to vary a great deal above and below these diversions (Table 9). Completely dewatered conditions existed below the Upper Salmon River and Alturas Lake Creek diversions. These complete diversions have no provision for fish bypass, and there are no screens in the channels to prevent entrance of downstream migrating salmonoids to the irrigated fields. Upstream passage of adults is limited or precluded entirely by low flow and physical features of the diversion dam.

The diversions usually operate from a 2- to 3-month period, and segments of the stream channel below these diversions are dry or dewatered to the point it is eliminating desirable habitat.

The Salmon River Valley study area contains the bulk of the salmon spawning and rearing area. The bulk of the hatchery rainbow harvested from stream fishing are taken here. This area needs constant protection and special management to guarantee good conditions for salmon and steelhead spawning and rearing. The studies show that all required conditions for spawning are being met except optimum waterflows.

Sawtooth Low Lakes Area

Within the Sawtooth Valley moraine lands are found the larger lakes. Most of these large lakes have road access and in turn receive heavy recreation use. Due to their infertility and lack of species composition control, these lakes are not good fisheries. Even though they are large in size with deep depths they only produce a small native game fishery. The hatchery product stocked in these lakes contributes primarily to the fish creeled.

These lakes are low in chemicals or other foreign materials, as evidenced by Station 2 (Alturas Lake Creek) and Station 6 (Redfish Lake Creek). Work done in 1935 on the larger lakes also shows this infertility (Tables 10 and 11). Lakes such as Alturas, Redfish, and Pettit are very deep and have a small amount of their basin in shoal area which again holds their productivity down. Because of the large size of these lakes, it would be difficult to manipulate the environment or the biotic community to enhance the fishery.

These lakes, in their pristine condition, however, are the main attraction of the area, as witnessed by the recreation public massing into these areas. The recreationist ties himself to being near water. Some of these lakes (Pettit, Yellow Belly, Perkins, Hell Roaring, and Stanley) have been chemically treated by the Idaho Fish and Game Department and restocked with salmonoids.

Streams flowing through this area have generally changed to a lower gradient, slower velocity type environment than their headwater areas are in the glaciated land types. As a result, they become more gentle and, in turn, offer more to the fishery than the upstream areas.

Table 10 Physical and chemical data from Rodeheffer's* report (1935) for some of the larger lakes.

Lake	Area (acres)	Shoal (percent)	Depth (feet)	pH	O_2 (dissolved)	CO_2 (free)	HCO_3 (bicarbonates)	CO_3 (carbonates)
Alturas	1,200	03	220	6.8-7.0	7.0-9.5	1.0-2.0	12-23	0
Perkins	46	70	31	7.0	7.0-7.5	1.5-2.0	18-25	0
Pettit	350	25	200	6.2-6.5	5.0-9.4	1.5-1.5	-	-
Redfish	1,550	3	293	6.4-6.6	7.2-9.2	1.5-3.0	12-15	0
Redfish Little	76	75	25	6.8	7.0-7.2	1.5-2.5	12-15	0
Imogene	30	15	113	5.6	6.8-8.4	-	4-7	0
Toxaway	84	15	145	5.6	7.0-7.2	1.5	4-7	0

*A survey of the Waters of the Sawtooth National Forest, Idaho (1935), mimeo., by I. A. Rodeheffer, temporary biologist.

Table 11 Hydrochemical data conducted by A. W. Klotz (1938) in some of the larger lakes within the SNRA.

Lake	Total Solids	Alkalinity Bicarbonate	Hardness	pH
Alturas	52	23	24	7.1
Imogene	26	6	8	6.6
Redfish	68	11	20	7.0
Stanley	44	24	24	7.1

Sawtooth High Lakes Area

This area contains over 200 high mountain lakes with most of them containing fish populations. Very little is known about this aquatic habitat as there are few studies and practically no inventory of these environments. Because studies have been conducted in the adjacent White Cloud Area, it is possible to roughly determine or predict conditions in this area using information found in areas of similar environment.

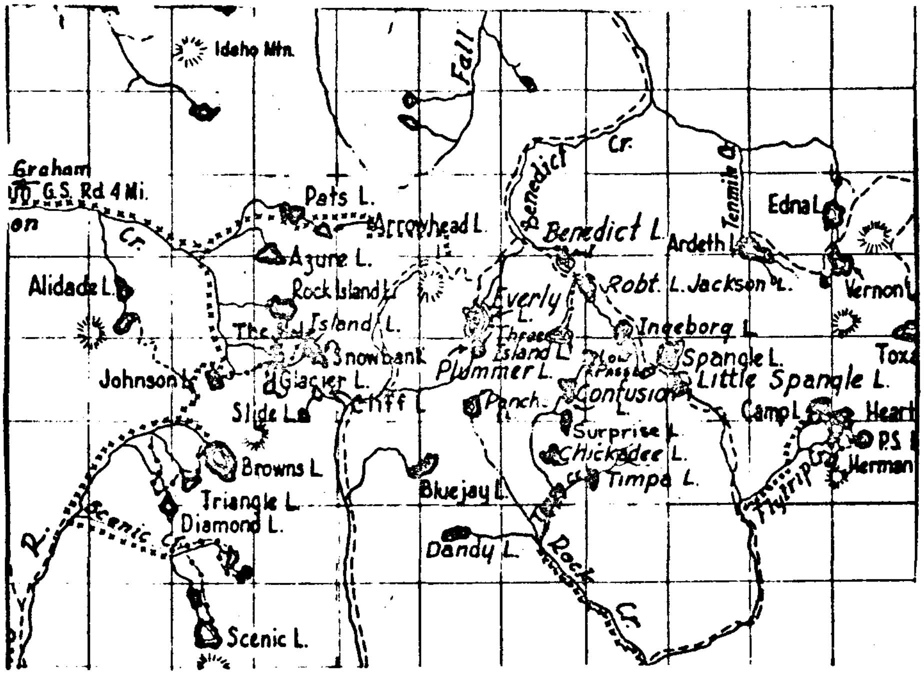
Some of the lakes within this area are not producing a fishery resource at the present time because of limiting factors. It will take a habitat inventory to pinpoint deficiencies. Some lakes do not produce because they lack sufficient depth or sufficient incoming waters. In some cases, the water levels in these lakes can be raised placing them back into production. Other lakes have adequate conditions most of the year, but lose their water during the dry season. Possibly some of these lakes can be placed into production by sealing the bottom or grouting the outlets.

Because of predominant granitic environment, lakes within this area tend to be low in fertility, thus food chain production can be low resulting in small standing crops of fish. Some lakes, however, are capable of building their own fertility. The future could see a need for artificial control of productivity in order to increase its potential for serving the recreationist. Chains of lakes could be increased for food production by fertilizing only the top lake. It is very possible that types of organisms now lacking in food chains, such as shrimp and salamanders, should be stocked in lakes (now devoid) that offer the right habitat.

The fishery within this area is due, almost entirely, to the ability of the basin to retain waterflows in the form of lakes where conditions become quite ideal in many cases for a salmonoid fisheries. Streams in this area are so dominated by high energy flows and icing conditions they offer relatively little to the fishery. The lakes are mainly found between 7,000 to 9,000 feet in elevation which means their ice-free period is short.

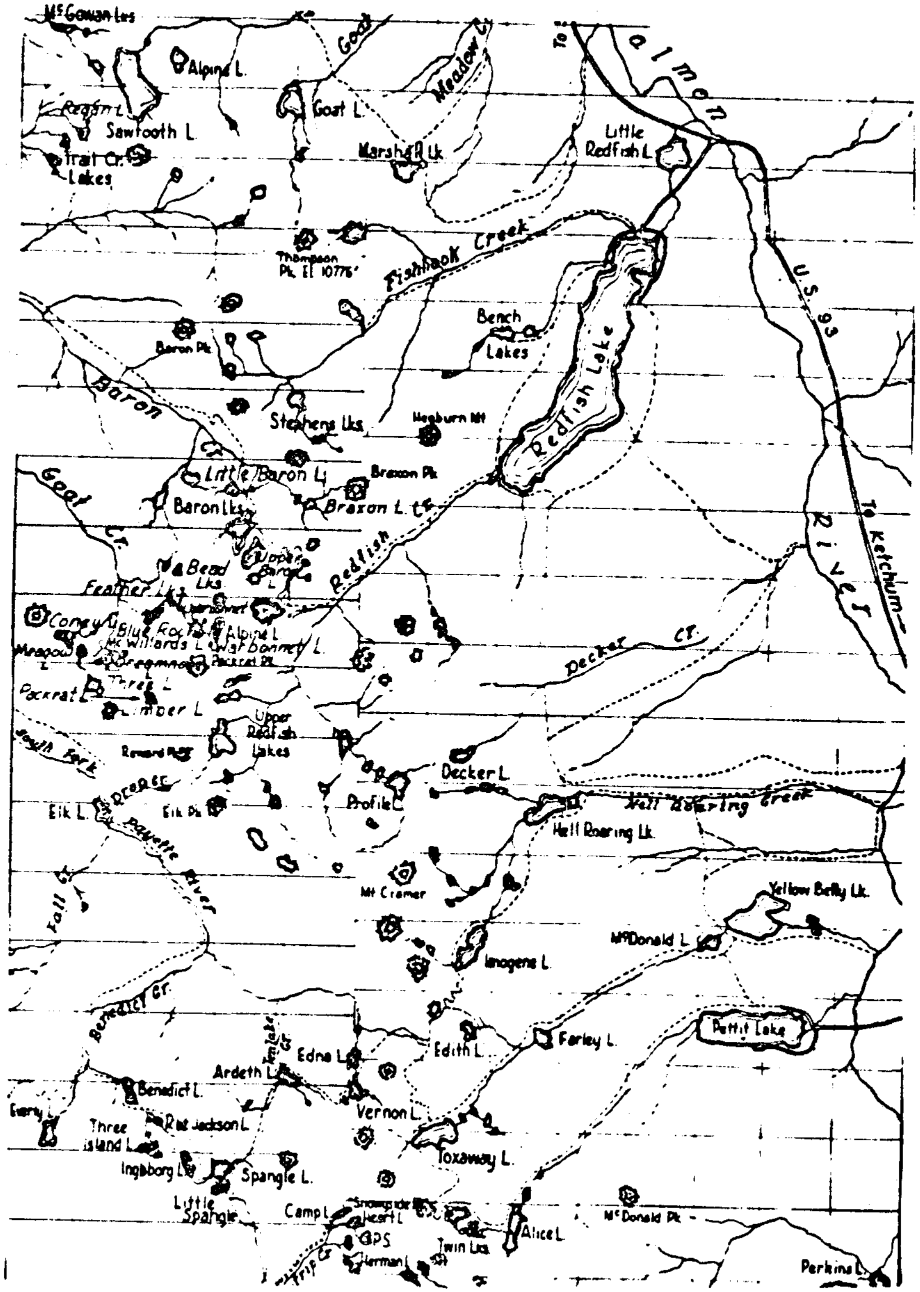
In lakes containing low gradient inlets, gravel bottom outlets, or inlake springs or seepage, they can produce spawning conditions that enable the trout population to reproduce successfully. In many cases, there is sufficient survival of the young to keep the lake producing at a maximum rate. These lakes need to be determined. Other lakes are incapable of supporting a fishery through natural means and must be continually stocked. These lakes also need to be identified. Other lakes offer the reproduction potential to the point that the lakes are overpopulated and fish competition for food and space results in stunted fish populations.

Because the author or other biologist have not had the time or funds available to do an aquatic environment study of this area, we have little to offer about describing conditions or pointing out problems to the land manager. In the future, this could be done.



Name of Lake	Species	Acres	Remarks
Alidade	DV	10	Large Dolly Varden present.
Ardeth	BR, RB	80	Fish numerous. Occasional large cutthroat taken.
Arrowhead . . .	CT	4	Fish 9-14".
Azure	CG	6	Few fish to 14".
Benedict	CT	5	Fish to 12".
Blue Jay	RB	12	Fish numerous, 10-12".
Browns	CG, CT	30	Few large California golden.
Camp	RB	2	Good camping facilities.
Chickadee . . .	CT	4	Small fish. No established trail.
Confusion . . .	RB	9	Good. No established trail.
Dandy	CT	15	Good. No established trail.
Diamond	CT, RB	4	Few fish 1-2 pound.
Edna	BR, CT	16	Fish numerous. Occasional large cutthroat taken.
Everly	CG	7	California golden to 3 pounds.
Flattop	RB	4	
Heart	CT, CG	8	Cutthroat numerous. 9-12". Few California golden.
Herman	CT	4	
Hole, The . . .	CG, CT	4	California golden to 2 pounds.
Ingeborg . . .	RB, CT	80	Fish to 14".
Island	CT	5	
Jackson, Robert . .	RB	4	
Low Pass	CT	8	Excellent. No established trail.
Naneke	RB	3	
P.S.	CG	4	Large California golden present.
Pancho	CT	4	Good. No established trail.
Pats	CT	5	Fish to 2 3 pounds.
Plummer	CT	6	Mostly 7-10".
Rock Island . . .	CG	6	Fish numerous, to 14".
Spangle	BR	120	Fish numerous, 7-8".
Spangle (little) . .	BR	40	Fish numerous, 7-8".
Scenic	CT	20	
Scenic (little) . . .	CT	3	Fish to 14".
Snowbank . . .	CT	5	
Surprise	RB	10	Good fishing. No established trail.
Three Island . . .	CT	8	Fish to 14".
Timpa	CT	5	Shallow.
Triangle	CT	3	Few fish to 14".
Vernon	BR, CT	12	Fish numerous. Occasional large cutthroat taken.

Figure 7 High mountain lakes (southwest division) in the Sawtooth High Lake Area with fish species, approximate size of lake, and remarks taken from Mountain Lakes of Idaho by the Idaho Fish and Game Department.



Name of Lake	Species	Acres	Remarks
Alpine (Redfish Cr.)	BR	40	Excellent population brook trout.
Alpine (Iron Cr.) .	CG	5	Golden trout occasionally to 4 pounds.
Baron	RB, BR	90	Many brook, occasionally large rainbow.
Baron (little) . . .	BR	4	Numerous 7-10" brookies.
Baron (upper) . .	RB	30	Fair to good, 8-12" fish.
Bead (2)	CT	2-3	Should be good.
Bench (2)	BR	3-8	Short hike, large population of small fish.
Braxon	RB	3	Fair to good, small trout.
Blue Rock	CT	8	No trail, good cutthroat, 8-12".
Coney	CG	10	Excellent fly fishing, small golden.
Decker	RB	5	No trail, some large rainbow.
Edith	BR	6	High population, small trout.
Farley	BR	30	Good trail, good population brook trout.
Feather (2) . . .	CG	1-2	Results unknown, rough area.
Hell Roaring . . .	BR	90	Good trail high population.
Imogene	BR, CT	70	4 lakes; excellent fishing.
Limber		4	Not stocked.
Marshall	BR	6	Excellent population, Meadow Creek trail.
McGowan	CT	3-5	Good sized trout, 10-16".
McWilliams . . .	RB	4	No trail, good small trout.
Meadow	BR	3	Trout to 12".
Oreamnus	RB	17	Rainbows from 8-15".
Packrat	RB	15	Trout 12-16", no trail, rough.
Profile	BR	20	No trail, rough, good fish, 12".
Redfish (upper) . .	BR	18	No trail, excellent fishing.
Regan	CG	4	Goldens to 15", no trail.
Sawtooth	BR	200	Excellent angling, good camping, large lake.
Stephens	BR	7	Numerous small "brookies".
Three	BR	20	High population trout to 12".
Trail	RB	6	Trout to 16", Payette drainage.
Toxaway	BR	90	Excellent trail, camp, numerous trout.
Warbonnet . . .	CG	10	Fair to good, trout to 12".
Warbonnet (little) .	CG	5	Good fly fishing, no trail.
Yellow Belly . . .	RB	170	Road to lake.

Figure 8 High mountain lakes (northeast division) in the Sawtooth High Lake Area with fish species, approximate size of lake and remarks taken from <u>Mountain Lakes of Idaho</u> by the Idaho Fish and Game Department.

Sawtooth West Side

The Sawtooth west side drains into the Boise and Payette River drainage, therefore, anadromous fish do not have access to the area. No inventory or environmental studies have been done in this area and very little is known about the environmental conditions or the fishery populations.

This area is almost devoid of lakes as the glaciation period had little effect in this area other than depositional materials. The streams also rate quite poor as habitat and contain mainly small sized trout. The streams are mainly quite small except the major tributary. By the time these streams do start gaining size they either enter the main tributary or leave the area.

We have little to offer, as far as aquatic environment interpretation in this area as studies and data are lacking. Hopefully, this can be corrected in the future.

White Cloud Lake Area

The White Cloud Lake fishery lies mainly in the high alpine-type environment. In many ways, it is quite similar to the Sawtooth High Mountain Lake Area. This area, like the Sawtooth High Lake Area, is characterized by very rugged, glaciated mountain canyons with cirque basins in the higher elevations with steep gradient sagebrush-aspen slopes in the lower elevations. About 120 high mountain lakes offer the lacustrine aquatic habitat, but only about half of them are capable of sustaining fish populations.

During the 1920's and 1930's, both native and exotic fishes were stocked in many of the lakes. Brook trout were stocked indiscriminately in some lakes and streams. They produced fair fisheries in some waters, but some lakes and streams suffered because of the tendency of brook trout to become over-populated and stunted. The fishery is very similar to the type found within the Sawtooth High Lake Area.

The processes that act upon the surface of the lands to produce the aquatic environment are well demonstrated in this area. The running water and mass movement of complexes of soil, water, and ice have formed one of the more esthetic-type fisheries available. The pattern of the surface drainage is almost wheel-like with headwaters starting from a common center point. Because of the high elevations, the energy forces become available for digging and rotating and moving rock and soil masses which gave us the aquatic environment. When this environment is compared with other glaciated areas (Pioneers and Boulders), it demonstrates the importance of combining factors in producing a desirable aquatic environment.

Table 12 Average physical conditions of 101 High Mountain Lakes in the White Cloud Area (water depth in feet, remainder in percent

Water Depth	
Average maximum	33.5
Average depth	19.8
Water Stability	
Stable	73
Slightly unstable	1
Very unstable	6
Extreme unstability	13
Complete loss of water	7
Natural Reproduction	
Yes	26
Possible	5
Doubtful	8
None	61
Fish Occurrence	
Cutthroat trout	31
Rainbow trout	29
Brook trout	4
Dolly Varden	1
Lake barren	45
Lake Shoal Area	
Percent of lake in shoal area	64
Shoal area with rock bottom	44
Shoal area with fines	56
Rooted Aquatics	
None	60
Sparse	14
Abundant	26
Fish Condition	
Excellent	17
Good	21
Fair	4
Poor	13
Fishery Potential	
Supports fishery	58
Does not support fishery	42

Table 13 **Physical condition of lakes in the White Clouds area**

	Depth Max. (ft)	Depth Ave. (ft)	Elevation (ft)	Fluctuation	Natural Reproduction	Fish Species	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition	Fishery Potential *
Hourglass	12	8	9,371	Stable	Yes	R	100	0	100	none	Poor	1
Island	29	18	9,280	Stable	Yes	C,R	45	10	90	none	Fair	1
Jennifer	6	3	9,400	Stable	None	?	100	10	90	none	-	2
4th July	14	5	9,365	Stable	Yes	C,B	100	10	90	abundant	Good	1
5th July	4	3/4	9,365	Unstable	None	None	100	30	60	abundant	None	2
Klaush	4	2	8,390	Extreme	None	None	100	20	80	None	None	2
Lightning	84	62	9,600	Stable	None	C	10	100	0	None	Good	1
Little Redfish	22	16	8,790	Stable	Yes	C	35	0	100	Abundant	Good	1
Lodgepole	0	0	9,440	Drys up	None	None	100	100	0	None	None	2
Lodgepole	73	56	9,008	Stable	Yes	R	5	60	40	Sparse	Poor	1
Lower Ocalkens	56	28	9,020	Stable	None	?	30	20	80	Sparse	-	1
Lonesome	185	87	10,435	Stable	None	R	15	100	0	None	Good	1
Martha	26	20	9,520	Stable	None	R,C	45	40	60	None	Good	1
Neck	2	½	10,040	Stable	None	None	100	20	70	None	None	2
Noisy	72	72	8,997	Stable	Possible	R,C	5	-	-	None	Good	1
Upper Ocalkens	31	11	8,872	Stable	Possible	?	80	15	85	Sparse	-	1
Penstemon	3	1	9,440	Extreme	None	None	100	100	0	None	None	3
Phyllis	12	9	9,200	Stable	Doubtful	C	100	10	90	None	Excellent	1
Pika	0	0	9,440	Drys up	None	None	100	60	40	None	None	2
Pine	0	0	9,440	Drys Up	None	None	100	100	0	None	None	3
Pipe	15	10	9,040	Stable	Possible	No	100	40	60	None	-	2
Porcupine	4	1	8,600	Extreme	None	None	100	5	95	Abundant	None	2
Pothole	9	6	9,680	Unstable	None	None	100	65	35	Abundant	None	2
Pot	1	1/3	-	-	None	None	100	40	60	None	None	3
Quiet	85	61	9,242	Stable	Yes	R	5	80	20	None	Good	1
Rain	3	1	9,400	Stable	None	None	100	15	85	None	None	2
Rainbow	12	6	8,457	Stable	Yes	C	100	10	90	Sparse	Good	1
Rock	18	4	9,920	Stable	None	C	80	100	0	None	Good	1
Rosie	6	2	9,920	Extreme	None	None	100	80	20	Sparse	None	2
Salamander	5	3	9,560	Unstable	None	None	100	50	50	Abundant	None	2
Sapphire	135	91	9,880	Stable	None	R	6	85	15	None	Excellent	1
Scoop	37	27	9,643	Stable	Yes	R	5	40	60	None	Poor	1
Shallow	30	23	9,514	Stable	Yes	R	10	-	-	None	Poor	1
Sheep	83	51	9,875	Stable	None	R	5	6	40	None	Excellent	1
Shelf	55	35	8,939	Stable	Yes	R	5	55	45	Sparse	Poor	1

Shrimp	3	1	8,960	Drys up	None	None	100	-	-	Abundant	None	1
Silicon	8	4	9,780	Stable	No	None	100	20	80	None	None	2
Sink	28	18	9,200	Stable	None	None	10	40	60	Sparse	None	2
Six	140	28	8,840	Stable	Yes	C,R	15	20	80	Sparse	Good	1
Slide	18	5	10,190	Stable	None	None	80	60	40	None	None	2
Slide	4	2	9,240	Stable	None	None	100	10	90	None	None	2
Sliderock	40	26	9,978	Stable	Yes	R	20	60	40	Sparse	Poor	1
Snow	57	35	10,050	Stable	None	C	5	95	5	None	Excellent	1
Sullivan Lake	7	3	5,650	Stable	None	None	100	10	90	Abundant	None	2
Three-in-one N.	17	11	9,260	Extreme	None	None	40	20	80	None	None	2
Three-in-one S.	18	11	9,260	Extreme	None	None	40	20	80	None	None	2
Three-in-one W.	15	10	9,260	Stable	None	None	40	20	80	Sparse	None	2
Thunder	-	-	9,200	Stable	None	C	100	30	70	-	-	1
Tin Cup	104	72	9,980	Stable	None	C	10	-	-	None	Good	1
Tiny	3	2	9,500	Stable	Yes	R	100	0	100	None	Poor	1
Upwell	10	4	9,540	Stable	Possible	C	100	30	70	None	Excellent	1
Walker	40	24	9,239	Stable	Yes	R	15	10	90	Sparse	Poor	1
Waterdog	4	2	8,640	Unstable	None	None	100	0	100	Abundant	None	2
Washington	13	10	9,362	Stable	Yes	B	100	20	80	Sparse	Poor	1
Willow	5	4	8,735	Stable	Yes	R	100	0	100	Abundant	Poor	1
Baggley	4	2	8,700	Extreme	None	None	100	-	-	None	None	2
Baker	4	3	8,472	Stable	Yes	C,R,DV	100	3	97	Abundant	Excellent	1
Bluff	1	½	9,240	Extreme	None	None	100	0	100	Abundant	None	3
Bog	1	1/3	9,560	Stable	None	None	100	-	-	-	None	3
Born-Lower	5	3	9,400	Stable	Yes	C	100	50	50	Abundant	Good	1
Born-Middle	9	6	9,440	Stable	Yes	C	100	40	60	Abundant	Good	1
Born-Upper	22	10	9,550	Stable	Yes	C	80	15	85	Abundant	Good	1
Boulder	21	16	10,050	Stable	None	No	10	40	60	None	None	2
Buck	6	3	9,280	Extreme	None	None	100	50	50	-	None	2
Carex	2	½	9,440	Stable	None	None	100	0	100	Abundant	None	3
Castle	78	46	9,419	Stable	Doubtful	C		90	10	None	Excellent	1
Castleview	130	64	9,280	Extreme	None	C	10	80	20	None	Fair	1
Chamberlin	14	8	9,197	Stable	None	?	100	30	70	Abundant	-	1
Champion-Lower	128	57	8,593	Stable	Yes	B	10	10	90	Abundant	Good	1
Champion-Middle	5	2	8,640	Stable	None	-	100	10	90	Abundant	-	2
Champion-Upper	130	56	8,661	Stable	Yes	B	10	10	90	Abundant	Fair	1
Cirque	85	56	10,000	Stable	None	R,C	15	80	20	None	Excellent	1
Colloid	5	2	9,160	Stable	None	None	100	-	-	Abundant	None	2
Columbine	0	0	9,440	Drys up	None	None	100	-	-	None	None	3
Cornice	28	20	9,860	Slight	Doubtful	C	20	90	10	None	Excellent	1
Cove	148	104	9,842	Stable	Doubtful	R,C	5	100	0	None	Excellent	1
Crater	150	47	8,919	Stable	Doubtful	C	20	90	10	None	Good	1
Deer	27	17	9,600	Stable	Possible	R,C	25	80	20	Sparce	Good	1

Di-Oxide	45	37	9,180	Stable	Doubtful	R	5	70	30	None	Excellent	1
Doe Lake	4	2	9,280	Extreme	None	None	100	0	100	None	None	2
Drift	5	2	9,635	Stable	None	No.	100	35	65	Sparce	-	1
Dry	0	0	8,960	Drys up	None	None	100	-	-	Abundant	-	3
Dyke	14	5	10,000	Stable	None	No.	100	70	30	None	-	2
Emerald	-	-	8,700	Stable	None	None	-	100	0	None	None	2
Emerald	33	22	9,910	Stable	None	C	25	90	10	None	Excellent	1
Feldspar	34	28	9,615	Stable	Possible	C,R	10	85	15	None	Good	1
Frog-Big	31	23	8,855	Stable	Yes	R,C	10	0	100	Abundant	Excellent	1
Frog-Little	29	26	8,840	Stable	Yes	R,C	5	0	100	Abundant	Good	1
Full Moon	1	½	9,980	Stable	None	None	100	-	-	-	None	2
Gentain	19	12	10,050	Stable	None	No.	50	90	10	None	-	1
Glacier	-	-	9,980	Stable	None	C	100	100	0	Sparse	Good	1
Goat	45	34	8,920	Stable	Doubtful	R	10	80	20	None	Excellent	1
Goldenrod	0	0	9,440	Drys up	None	None	100	-	-	None	None	3
Granite	9	3	9,960	Stable	None	None	100	35	70	None	None	2
Grass	6	3	9,440	Extreme	None	None	100	90	10	-	None	2
Gunsight	81	57	10,000	Stable	Doubtful	C	5	50	50	None	Excellent	1
Half	-	-	9,440	Extreme	None	None	100	10	90	None	None	3
Half Moon	12	3	9,860	Stable	None	None	100	40	60	None	None	2
Hatchet	36	16	8,884	Stable	Yes	R	20	5	95	Abundant	Poor	1
Headwall	25	18	9,755	Stable	None	R	10	-	-	None	Excellent	1
Heart	130	58	9,477	Stable	Yes	C	10	-	-	None	Good	1
Hidden	12	9	9,980	Stable	Doubtful	R	100	50	50	None	Poor	1
Hoodo	110	47	8,677	Stable	None	R	20	50	50	Sparse	Good	1
Honey	38	15	9,580	Stable	None	C	45	15	85	None	Fair	1
Hope	12	6	9,849	Unstable	None	None	100	10	90	None	None	2

Key

B Brook Trout
C Cutthroat
DV Dolly Varden
R Rainbow
N.O. None Observed

Fishery Potential
1 Supports fishery
2 Does not support a fishery
3 Lake goes dry

Due to lower elevations and possibly structure, the Pioneers and Boulder Areas were not as successful in producing the size and depth of lacustrine environment necessary to have the magnitude of good lake waters available.

Since the last glaciation period, many of the lakes (no differentiation between ponds and lakes) have had time to fill with sediment, form meadows, or cut through their natural dams. As stated before, the present fishery potential of the lacustrine habitat is not near the magnitude it must have been just after the last glaciation period. However, today many of the lakes have high heat budgets and adequate dissolved oxygen storage to carry them through critical periods. Because annual heat budgets and dissolved oxygen storage are controlling or limiting factors in many lakes, depth plus water inflow can determine whether a lake will produce a fishery or not.

To determine the potential of the lakes to support a fishery, physical, biological, and minor hydrochemical studies were made of each individual lake. (See the White Cloud-Boulder-Pioneer Aquatic Environment and Fisheries Study - Interim Report for more detailed information.) All lakes in the White Cloud Area have been inventoried and studies except Bear and Swimm. For more insight into the types of data collected and the methods of collection, refer to Appendix I for "Methods and Techniques."

Little Boulder Drainage

All 26 lakes were studied in this drainage, and all but three were supporting fisheries. (See Figure 9.) The Little Boulder chain drainage lakes are mainly overpopulated by rainbow trout. Conditions within the system are excellent for natural reproduction and survival (Tables 13 and 14). In all

lakes but Lonesome and Headwall (in the Boulder chain group), this has resulted in stunted trout populations due to overcompetition. In lakes suitable for trout, the factor that most profoundly affects trout survival and growth is competition. It is possible, that as fishing pressure builds up, this problem may take care of itself. This series of lakes does provide a fishing area where all participants can go and be successful in catching trout.

The Little Boulder chain drainage contains mainly rainbow with very few cutthroat. The variety of the resource harvested, to a degree, enhances angler satisfaction. It is possible that lakes controlled for certain species or a proper mix of species, might offer a more desirable type recreation to the user.

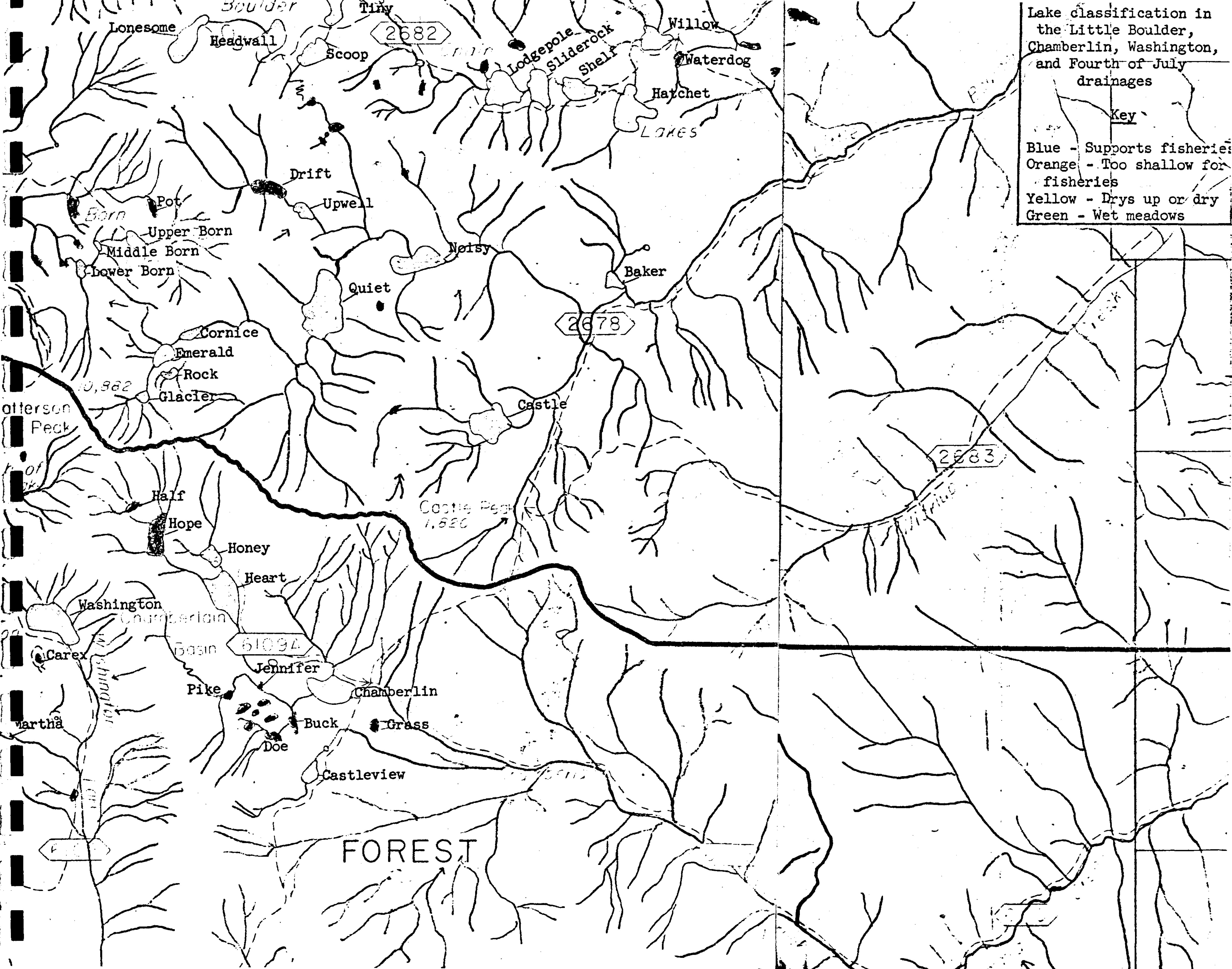
Within the Little Boulder drainage there are also a few lakes that produce trophy trout. Frog Lake is well-known for its reputation of growing large hard-to-catch cutthroat, rainbow, and brook trout. It received heavy fishing pressure. Because of its high productivity, it is capable of producing larger standing crops of fish per unit area than most of the other lakes in this area. When trout grow rapidly, it can be assumed their food is readily available, as food availability is the key to fast growth. This explains the major reason why the reduced growth rates in most of the Little Boulder chain lakes where natural spawning has increased trout numbers to the point that adequate food is not available.

Frog Lake does not have extremely fertile inflow waters, but depends on its almost 100 percent shoal area for food production. The bottom is a soft organically rich soil with large areas of rooted aquatics. The shallow depth allows the complete bottom to produce into the food chain.

TABLE 14 Physical conditions of lakes in the Little Boulder drainage, White Cloud area

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition
Castle	78	46	9,419	Stable	Doubtful	C	40	90	10	None	Excellent
Cornice	28	20	-	Slight	Doubtful	C	20	90	10	None	Excellent
Baker	4	3	8,472	Stable	Yes	C, R, DV	100	3	97	Abunaant	Excellent
Drift	5	2	9,635	Stable	None	NO	100	35	65	Sparse	None
Emerald	33	22	-	Stable	None	C	25	90	10	None	Excellent
Frog Big	31	23	8,855	Stable	Yes	R, C	10	0	100	Abundant	Excellent
Frog Little	29	26	8,840	Stable	Yes	R, C	5	0	100	Abundant	Good
Glacier	-	-	-	Stable	None	None	100	100	0	Sparse	None
Hatchet	36	16	8,884	Stable	Yes	R	20	5	95	Abundant	Poor
Headwall	25	18	9,755	Stable	None	R	10	-	-	None	Excellent
Hidden	12	9	9,517	Stable	Doubtful	R	100	50	50	None	Poor
Hourglass	12	8	9,371	Stable	Yes	R	100	20	80	None	Poor
Lodgepole	73	56	9,008	Stable	Yes	R	5	60	40	Sparse	Poor
Lonesome	185	87	10,435	Stable	None	R	15	100	0	None	Good
Noisy	72	72	8,997	Stable	Possible	R, C	5	-	-	None	Good
Quiet	85	61	9,242	Stable	Yes	R	5	80	20	None	Good
Rock	18	4	-	Stable	None	C	80	100	0	None	Good
Shallow	30	23	9,514	Stable	Yes	R	10	-	-	None	Poor
Scoop	37	27	9,643	Stable	Yes	R	5	40	60	None	Poor
Shelf	55	35	8,939	Stable	Yes	R	5	55	45	Sparse	Poor
Sliderock	40	26	8,978	Stable	Yes	R	20	60	40	Sparse	None
Tiny	3	2	9,500	Stable	Yes	R	100	0	100	None	Poor
Upwell	10	4	9,540	Stable	Possible	C	100	30	70	None	Excellent
Waterdog	4	2	8,640	Unstable	None	None	100	0	100	Abundant	None
Willow	5	4	8,735	Stable	Yes	R	100	0	100	Abundant	Poor
AVERAGES	38	25	9,234	Stable 92%	Doubtful 12%	R 68%	47%	46%	54%	Abundant 24%	Excellent 28%
				Unstable 4%	Yes 52%	C 36%				Sparse 20%	Good 20%
				Slight 4%	None 28%	DV 4%				None 56%	Poor 36%
					Possible 8%	NO 4%					None 16%
						None 8%					
						Total 120%					

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW



Lake classification in the Little Boulder, Chamberlin, Washington, and Fourth of July drainages
Key
Blue - Supports fisheries
Orange - Too shallow for fisheries
Yellow - Drys up or dry
Green - Wet meadows
Boulder
Tiny
2682
Lonesome
Headwall
Scoop
Lodgepole
Sliderock
Shelf
Willow
Waterdog
Hatchet
Lakes
Drift
Upwell
Pot
Born
Upper Born
Middle Born
Lower Born
Noisy
Quiet
Baker
2678
Cornice
Emerald
Rock
Glacier
Castle
2683
Half
Hope
Honey
Heart
Castle Peak
Washington
Chamberlain
Basin
61094
Carex
Jennifer
Pike
Chamberlin
Buck
Grass
Doe
Martha
Castleview
FOREST

TABLE 15 Physical conditions of lakes in the Big Boulder Creek drainage, White Cloud Area

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Rock	Fines	Aquatic Rooted Plants	Fish Condition
Boulder	21	16	10,050	Stable	None	NO	10	40	60	None	None
Cirque	85	36	10,000	Stable	None	R, C	15	80	20	None	Excellent
Cove	148	104	9,842	Stable	Doubtful	R, C	5	100	0	None	Excellent
DiOxide	45	37	9,180	Stable	Doubtful	R	5	70	30	None	Excellent
Dyke	14	5	10,000	Stable	None	NO	100	70	30	None	Excellent
Fieldspar	34	28	9,615	Stable	Possible	R, C	10	85	16	None	Good
Gentian	19	12	10,050	Stable	None	NO	50	90	10	None	-
Goat	45	34	8,920	Stable	Doubtful	R	10	80	20	None	Excellent
Granite	9	3	9,980	Stable	None	None	100	35	70	None	None
Gunsite	81	57	10,000	Stable	Doubtful	C	5	50	50	None	Excellent
Island	29	18	9,280	Stable	Yes	R, C	45	10	90	None	Fair
Neck	2	½	10,040	Stable	None	None	100	20	70	None	None
Redfish (Little)	22	16	8,790	Stable	Yes	C	35	0	100	Abundant	Good
Sapphire	135	91	9,880	Stable	None	R	6	85	15	None	Excellent
Silicon	8	4	9,780	Stable	NO	None	100	70	80	None	None
Snow	57	35	10,050	Stable	None	C	5	95	5	None	Excellent
Slide	18	5	10,190	Stable	None	None	80	60	40	None	None
Tincup	104	72	9,980	Stable	None	C	10	-	-	None	Good
Walker	40	24	9,239	Stable	Yes	R	15	10	90	Sparse	Poor
AVERAGES	48	31	9,727	Stable 100%	Yes 16%	C 42%	37%	55.5%	42%	Abundant 5%	Excellent 44%
					Possible 5%	R 42%				Sparse 5%	Good 17%
					Doubtful 21%	NO 16%				None 90%	Fair 6%
					NO 5%	None 21%					Poor 6%
					None 53%	Total 121%					None 28%

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

This lake, because of its high use, deserves further study as it is approaching that time in its life span when it may have problems containing adequate amounts of free oxygen. It is possible both Big and Little Frog Lakes may need to be raised a yet undetermined number of feet to insure good aquatic environment conditions. Frog Lake may be becoming overfertile, and it is felt by the author that the heavy grazing and bedding ground use by cattle around its shores are contributing. Also, it detracts from the fishermen's enjoyment and esthetics to have campgrounds full of cattle.

Baker and Willow Lakes have been affected by mining operations. Baker Lake, which is quite shallow (4 feet maximum depth), but produces a good fishery due to large inflows. It has been raised about 2 feet by an artificial dam. This is good for the fishery, but it could someday wash out. This lake does need to be raised to increase the fishery output.

Willow Lake, another very shallow lake, has received damages due to present mining activities. Materials from core drilling operations, due to the stillness of the receiving waters of the lake, have sedimented on the bottom covering the aquatic plant and animal life. The more heavily sedimented area covered approximately 6,000 square feet. This would reduce the capacity of the lake bottom, for an undetermined length of time, to produce a fish food supply. The trout population within the lake is already in the stunted condition.

Big Boulder Drainage

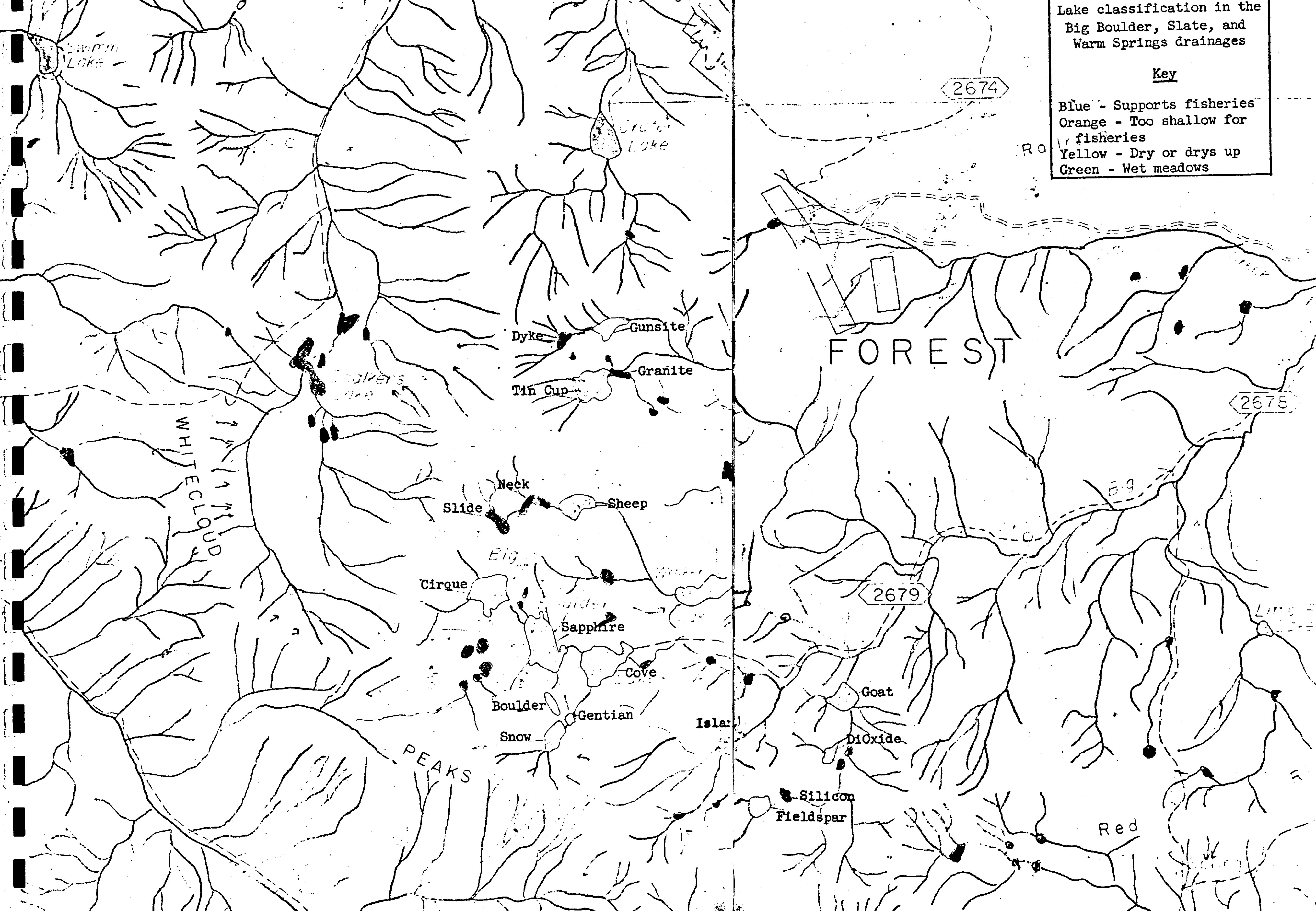
Big Boulder Creek could drain slightly more fertile parent materials than Little Boulder Creek as it is slightly more fertile. For more detailed

hydrochemistry, refer to the hycrochemistry section. The upper drainage lakes--Sapphire, Cirque, Cove, Gunsight, etc.--are prime examples where the waters alone are capable of producing both large trout and fairly large populations. These lake bottoms are composed primarily of bedrock, boulders, rubble, and gyttja. The shoals don't have the complete capability of providing the large mass of available food needed to support the populations, but the water environment contributes heavily. These lakes have large populations of zooplankton composed mainly of copepods and cladocerans.

Trout can grow rapidly on an invertebrate diet in these type lakes, if stocking numbers are closely controlled. Sapphire Lake (1969-1970) contained many large trout in the 3- to 8-pound class and is capable of producing larger trout in the 10- to 20-pound class. In lakes of British Columbia, trout have reached 40 pounds on strictly invertebrate diets.

The lakes in the Big Boulder Creek drainage (Table 15) are some of the larger, deepest lakes found in the lake surveys. It is believed that many lakes in the Sawtooths are deeper. Because of more space, recruitment from both natural and artificial means is less likely to oversaturate these lakes than much smaller lakes. Also, angling mortality is usually less in the bigger lakes in proportion to a unit area which allows individual members of the trout population to reach a larger size by living longer.

Walker Lake, however, is the square peg that does not fit in with the above observations. This lake is capable of supporting larger size trout, but, because of its inlet, outlet, and ideal shoal spawning production areas, it



Lake classification in the
Big Boulder, Slate, and
Warm Springs drainages
Key
Blue - Supports fisheries
Orange - Too shallow for
fisheries
Yellow - Dry or drys up
Green - Wet meadows
2674
2678
2679
FOREST
WHITECLOUD
PEAKS
Red
Dyke
Gunsite
Granite
Tin Cup
Neck
Slide
Sheep
Cirque
Sapphire
Cove
Boulder
Gentian
Snow
Goat
DiOxide
Silicon
Fieldspar

produces more young each year than the lake is capable of feeding. It does, however, provide a needed fishery by offering a lake where it is very easy to catch trout, and, in this way, it is undoubtedly a very valuable contributor to the overall recreational resource.

Big Boulder drainage (Figure 10) has one of the same drawbacks as the Little Boulder drainage aquatic environment in that it lacks diversity of species to be caught. It contains rainbow and cutthroat, and, at one time, California goldens. Due to stocking cutthroat trout over already existing California golden populations, the "goldens" could have been pushed out. It could possibly be more desirable to the recreationist if he had more of a variety in the drainage he is fishing. In this drainage, it could be possible, with added management, for the recreationist to visit a rainbow lake, cutthroat lake, "golden" lake, brook trout lake, and grayling lake all in one day. The Idaho Fish and Game Department did stock Sheep Lake with grayling during 1971 and this will add to the variety.

Like most other drainages, there are lakes that to date are not or have not supported fisheries. In many of these lakes, it is possibly feasible to change or eliminate these limiting factors and change the lake to a producing resource. Some of these needed rehabilitation measures are discussed for individual lakes in the White Cloud Lake-Boulder-Pioneer Aquatic Environment and Fisheries Study - Interim Report.

In the lower elevation portion of the study area, a shallow lake offers another seasonal type of recreation. Jimmy Smith Lake, a very shallow lake with a maximum depth of only 14 feet, lies both on Forest Service and

Bureau of Land Management lands. The bulk of the lake is on Bureau of Land Management lands.

Jimmy Smith Lake is closed during most of the general fishing season and is opened mainly during winter conditions. It provides an ice fishery, which is highly prized by the fishermen. As demonstrated during the winter fishery of 1954-1955, about 800 fishermen caught 8,355 trout for 3.9 fish per hour, or an average of 10.4 fish per fisherman. With these statistics, it is easily determined why the lake is so popular. With the advent and ever increasing use of motorized snow transportation, lakes of this type will be more and more in demand. We will have a great increase in the demand for more winter fisheries in the White Cloud Area.

A lake, Sullivan Lake, just to the northwest, offers the potential for another Jimmy Smith Lake. It will not support fish at the present time, but feasibly could be placed into a fishery. A fishery biologist should study this lake and determine the procedures to place this lake into a producing fishery. It would further enhance the aquatic environment in this area. In this drainage, 21 lakes were studied with 9 not producing a trout population.

Fourth July Drainage

On the west side of the White Cloud High Lake area, the Fourth July drainage empties into the Main Salmon River. This drainage contributes quite fertile waters to the aquatic environment. Fifteen lakes were surveyed with 10 of them not producing a trout population (Table 16). Because of exposure and elevations, the glacial energy flows did not build the types of lacustrine environments needed to carry a fishery resource. The five lakes that do support

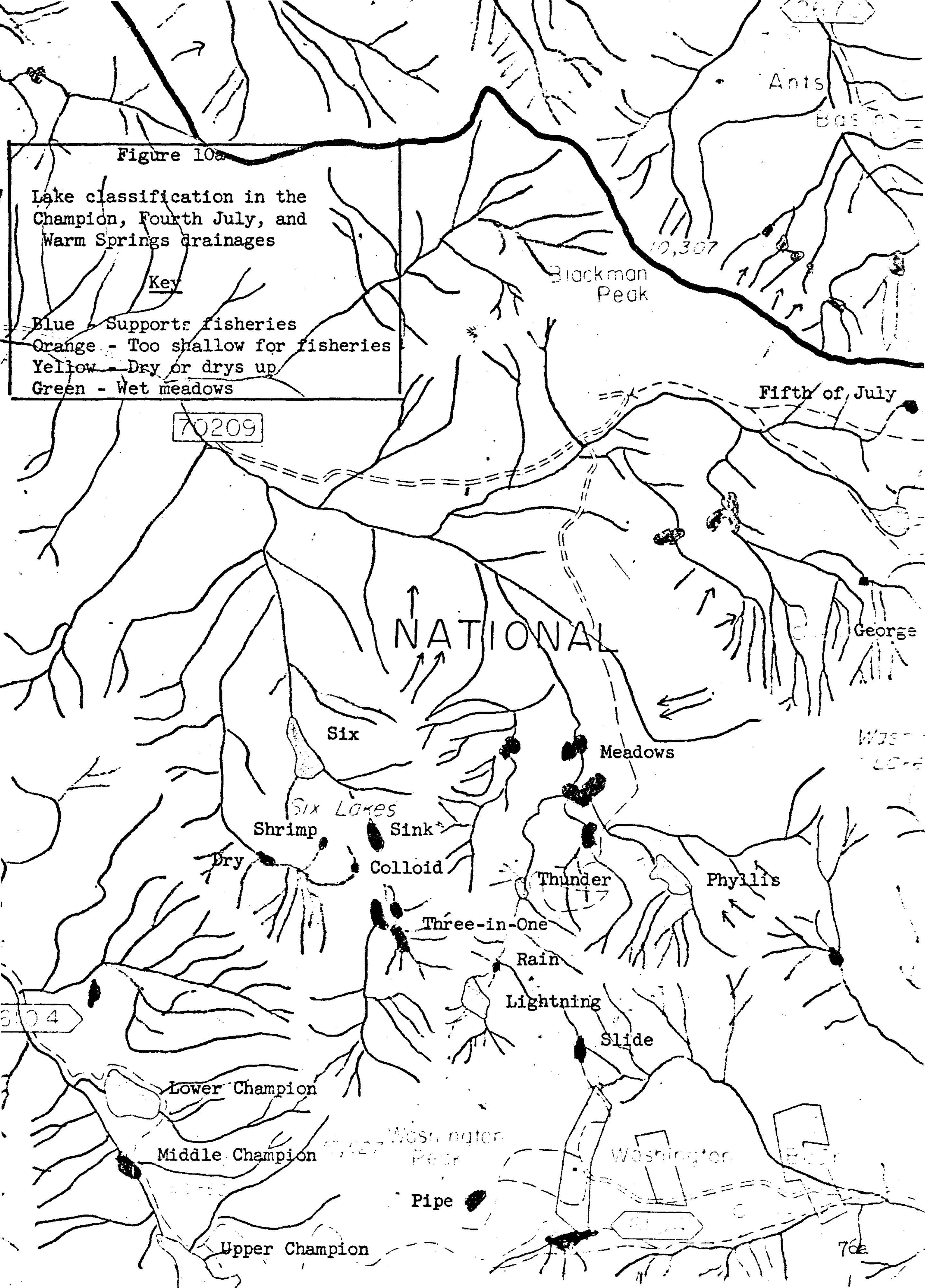


Figure 10a

Lake classification in the Champion, Fourth July, and Warm Springs drainages

Key

Blue - Supports fisheries
Orange - Too shallow for fisheries
Yellow - Dry or drys up
Green - Wet meadows

TABLE 16 Physical conditions of lakes in the Fourth July Creek drainage, White Cloud Area

Lake	Depth Max. (Feet)	Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition
Colloid	5	2	9,160	Stable	None	None	100	-	-	Abundant	None
Dry	0	0	8,960	Drys Up	None	None	100	-	-	Abundant	None
George	5	1	9,520	Unstable	None	None	100	80	20	Abundant	None
Fifth July	4	3/4	9,365	Unstable	None	None	100	40	60	Abundant	None
Fourth July	14	5	9,365	Stable	Yes	C, B	100	10	90	Abundant	Good
Lightning	84	62	9,600	Stable	None	C	10	100	0	None	Good
Phyllis	12	9	9,200	Stable	Doubtful	C	100	10	90	None	Excellent
Rain	3	1	9,400	Stable	None	None	100	15	85	None	None
Shrimp	3	1	8,960	Drys Up	None	None	100	-	-	Abundant	None
Sink	28	18	9,700	Stable	None	None	10	40	60	Sparse	None
Six	140	28	8,840	Stable	Yes	C, R	15	20	80	Sparse	Good
Thunder	-	-	9,200	Stable	None	C	100	30	70	-	-
Three-in-one, North	17	11	9,260	Extreme	None	None	40	20	60	None	None
Three-in-one, West	15	10	9,260	Stable	None	None	40	20	80	Sparse	None
Three-in-one, South	18	11	9,260	Extreme	None	None	40	20	80	None	None
AVERAGES	25	11	9,236	Stable 60%	Yes 14%	R 7%	70%	34%	66%	Abundant 43%	Excellent 7%
				Unstable 13%	Doubtful 6%	C 33%				Sparse 21%	Good 21%
				Extreme 13%	None 80%	B 7%				None 36%	None 72%
				Drys Up 14%		None 67%					
						Total 121%					

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

TABLE 17 **Physical conditions of lakes in the Chamberlin Creek drainage, White Cloud Area**

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Bottom Rock	Shoal Bottom Fines	Aquatic Rooted Plants	Fish Condition
Buck	6	3	9,280	Extreme	None	None	100	50	50	-	None
Castleview	130	64	9,280	Extreme	None	C	10	80	20	None	Fair
Chamberlin	14	8	9,197	Stable	None	None	100	30	70	Abundant	None
Doe	4	2	9,280	Extreme	None	None	100	0	100	None	None
Grass	6	3	9,440	Extreme	None	None	100	90	10	-	None
Half	-	-	9,440	Extreme	None	None	100	10	90	None	None
Heart	130	58	9,477	Stable	Yes	C	10	-	-	None	Good
Honey	38	15	9,580	Stable	None	C	45	15	85	None	Fair
Hope	12	6	9,849	Unstable	None	None	100	10	90	None	None
Jennifer	6	3	9,400	Stable	None	?	100	10	90	None	-
Pika	0	0	9,440	Drys up	None	None	100	60	40	None	None
AVERAGES	34	16	9,424	Stable 36% Unstable 9.5% Extreme 45% Drys Up 9.5%	Yes 9% None 91%	C 27% N 63% ? 10% Total 100%	86.5%	33.5%	64.5%	Abundant 11% None 88%	Good 10% Fair 20% None 70%

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

TABLE 18 **Physical conditions of lakes in the Champion Creek drainage, White Cloud Area**

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition
Champion Lower	128	57	8,593	Stable	Yes	B	10	10	90	Abundant	Fair
Champion Middle	5	2	8,640	Stable	None	-	100	10	90	Abundant	None
Champion Upper	130	56	8,661	Stable	Yes	B	10	10	90	Abundant	Fair
Rainbow	12	6	-	Stable	Yes	C	100	10	90	Sparse	Good
AVERAGES	69	30	8,631	Stable 100%	Yes 75% None 25%	B 67% C 33% Total 100%	55%	10%	90%	Sparse 25% Abundant 75%	Good 25 Fair 50 None 25

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

TABLE 19 Physical conditions of lakes in the Warm Springs drainage, White Cloud Area

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition
Bear	-	-	-	-	-	-	-	-	-	-	-
Born Lower	5	3	9,500	Stable	Yes	C	100	50	50	Abundant	Good
Born Middle	9	6	9,440	Stable	Yes	C	100	40	60	Abundant	Good
Born Upper	22	10	9,550	Stable	Yes	C	80	15	85	Abundant	Good
Pot Hole	9	6	9,600	Unstable	None	None	100	35	65	Abundant	None
Swim	-	-	-	-	-	-	-	-	-	-	-
AVERAGES	11	6	9,522	Stable 75% Unstable 25%	Yes 75% None 25%	C 75% None 25% Total 100%	95%	35%	65%	Abundant 100%	Good 75% None 25%

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

TABLE 20 Physical conditions of lakes in the Washington Creek drainage, White Cloud Area

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Rock	Bottom Fines	Aquatic Rooted Plants	Fish Condition
Carex	2	½	9,440	Stable	None	None	100%	0%	100%	Abundant	None
Martha	20	20	9,520	Stable	None	R, C	45%	40%	60%	None	Good
Pipe	15	10	9,040	Stable	Possible	NO	100%	40%	50%	None	-
Slide	4	2	9,240	Stable	None	None	100%	10%	90%	None	None
Washington	13	10	9,362	Stable	Yes	B	100%	20%	80%	Sparse	Poor
AVERAGES	12	8.5	9,320	Stable 100%	Yes 20% Possible 20% None 60%	R 20% C 20% B 20% NO 20% None 40% Total 120%	89%	22%	76%	Abundant 20% Sparse 20% None 60%	Good 25% Poor 25% None 50%

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW

TABLE 21 Physical conditions of lakes in the Slate Creek drainage, White Cloud Area

Lake	Depth Max. (Feet)	Depth Ave. (Feet)	Elevation (Feet)	Fluctuation	Natural Reproduction	Fish Species*	Shoal Area	Shoal Bottom Rock	Shoal Bottom Fines	Aquatic Rooted Plants	Fish Condition
Upper Ocalkens	31	11	8,900	Stable	Possible	NO	80	85	15	Abundant	None
Lower Ocalkens	56	28	8,750	Stable	NO	NO	-	20	80	Sparse	None
Crater	150	47	-	Stable	Doubtful	C	-	90	10	None	Good
Hoodoo	**	**	-	Stable	None	NO	10	50	50	Sparse	None
AVERAGES	79	21	8,825	Stable 100%	Possible 25% NO 25% Doubtful 25% None 25%	C 25% NO 75% Total 100%	45%	61%	38%	Abundant 25% None 25% Sparse 50%	Good 25% None 75%

*B = BROOK TROUT
C = CUTTHROAT
DV = DOLLY VARDEN
NO = NONE OBSERVED
R = RAINBOW
** = Depth measurement questionable due to unforeseen circumstance.

a fishery (Fourth July, Lightning, Phyllis, Six Lake, and Thunder) have high-producing fisheries. Most of the lakes in this area are hurting fishery-wise due to low heat budgets and low volumes of dissolved oxygen retention.

One large lake (Three-in-One) provides an opportunity to create a now unused fishery. With maximum depth of 18 feet and average depth of 11, it is fairly close to having adequate conditions at this time.

Germania Drainage

Twenty-five lakes were studied in the Germania Creek drainage, and 18 of these were not supporting fisheries (Table 17). South exposures plus elevations did not allow the glacial energies to develop good aquatic habitat conditions. This area is lacking for good fisheries at this time. Some of the Chamberlin Lakes at one time supported good California golden trout populations. Because of stocking of other species and possible failure of natural reproduction, it appears most of the "golden" population has died out.

Washington Lake supports a population of small, overpopulated brook trout. As mentioned for Walker Lake, it probably fulfills the demands by many recreationists by providing a water where almost anybody can catch a limit of trout.

Champion Creek Drainage

Eight lakes were inventoried in this 12-square mile drainage, and three were producing trout populations (Table 18). Lower Champion, Upper Champion, and Rainbow Lakes support good fisheries. Middle Champion Lake gets a drift of fish from Upper Champion, but these perish the following winter as it is too

shallow. It might possibly be developed into a fishery by providing more depth. Both Upper and Lower Champion Lakes are quite deep and offer excellent aquatic habitat conditions.

The Champion Lakes were stocked with eastern brook trout in 1922, and they are still the dominant species, even though rainbow and cutthroat trout have been stocked continually over them.

The drainage is quite fertile for an alpine-type environment. Both lakes range between 7.8 to 8.0 in pH and 72 to 75 in total alkalinity.

Warm Springs Drainage

Four lakes were studied at the very head of this drainage, and three of them contained excellent populations of cutthroat trout (Table 19). These lakes are very shallow, averaging only 6 feet in maximum depth. Because the aquifers produce year-round water into the bottom and sides of the lakes, it compensates for their low heat budget and dissolved oxygen containment. The lakes have the capability of naturally reproducing their own stock and have been taking care of themselves. These lakes have the ability of producing a very beautiful, highly colored cutthroat trout.

The upper lake (Pothole) has a maximum depth of 9 feet, the same as Middle Born and deeper than Lower Born, but it does not have an aquifer to compensate during critical winter conditions. It is very productive with a large display of aquatic invertebrates.

Table 22

Numbers of Cutthroat Trout Stocked in the White Cloud Area
from 1964 through 1971
(Except California Goldens in Gunsight Lake in 1970)

Lake	1964	1965	1967	1970	1971
Gunsight			830	*1,000	
Dyke			830	500	
No. 5			1,494		
Cove			2,490	2,000	
No. 10			498		
Sapphire			2,490	2,000	
Cirque			2,490	2,000	
Gentian			498		
Boulder			498		
Snow			830	500	
Island				500	
Goat			830	500	
No. 18			498		
No. 20				500	
Baker			830		
No. 2			498		
No. 3			498		
No. 4			2,490		
No. 5			498		
No. 6			498		
No. 7			498		
No. 8			498		
No. 11			498		
No. 12		1,425			
Castle			830	1,000	
Frog	4,000		498		
Sheep					**2,000

*California Goldens
**Grayling

Hydrochemistry

Hydrochemistry varies between lakes, between drainages, and between areas. It does help in determining the potential of streams and lakes to produce a fishery. The data also gives very valuable background documentation data to determine if land uses are causing any immediate, spatial, or temporal changes in the aquatic environment. The data in this report is just a start toward the documentation data needed to describe the hydrochemical portion of the fishery environment. This data allows the land manager to be in position to detect changes should they occur and in this way be able to step in and protect the fishery environment. All analysis of hydro samples was done by the Idaho State Health Laboratories, unless otherwise indicated.

All lakes tested during summer conditions contained an overabundance of dissolved oxygen with most of the lakes at or near free oxygen saturation at all time periods during the field season. It would be very interesting to do dissolved oxygen analysis in March or early April, as it would pinpoint those lakes having winterkill problems. Also, this should be tied in with changing water depths after snow cover and ice depression. This kind of data tied to fish survival and growth studies would unlock many of the White Cloud secrets.

No lakes were found to contain free carbon dioxide at dangerous quantities. Again, this would be a wintertime problem after icing conditions set in and not a summer problem.

The White Cloud waters are not as fertile as those sampled in the Boulders and Pioneers area and are basically less capable of producing a biomass.

Table 23

Summary of Lake Hydrochemistry in the White Cloud Study Area
Taken During 1968-1970*

Germania Drainage		Champion Creek Drainage		Fourth July Drainage		Big Boulder Drainage							Little Boulder Drainage		
Lake	Hardness CaCo3	Lake	Hardness CaCo3	Lake	Hardness CaCo3	Lake	Hardness CaCo3	pH	Phenol Alk	Total Alk	Free Acidity	Oxygen	Lake	Hardness	pH
Bluff	42	Baggly	85	Colloid	74	Boulder	-	7.0	-	-	-	-	Baker		8.0
Buck	69	Lower Champion	74	5th of July	18	Cirque	130	-	-	-	-	-	Cornice		7.0
Castleview	59	Middle Champion	72	4th of July	12	DiOxide	8	-	-	-	-	-	Drift, Upper		7.0
Chamberlin	25	Upper Champion	73	Lightning	23	Dyke	-	7.5	-	-	-	-	Emerald		7.0
Deer Lake	10	Emerald	59	Phyllis	52	Feldspar	8		-	-	-	-	Frog, Big	85	
Doe	106	Porcupine	59	Shrimp	9	Goat	25	7.8	0	20	-	-	Frog, Little	85	
Grass	16	Rainbow	93	Sink	32	Granite	-	7.0	-	-	-	-	Gentian	21	7.0
Heart	14			Six Lake	74	Gunsight	-	7.5	-	-	-	-	Glacier		7.0
Honey	10			Three-In-One (North)	38	Island	8	7.6	0	8	-	-	Hatchet	17	7.0
Hope	5			Thunder	25	Little Redfish	23	8.0	0	23	0	9.0	Headwall	17	7.0
Jennifer	15					Salamander	8	8.0	25	32	-	-	Lodgepole	17	7.0
Martha	20					Silicon	8	7.0	-	3	-	-	Lonesome	17	6.5
Pika	9					Tin Cup	-	7.0	-	-	-	-	Noisy		7.0
Pipe	42												Rock		7.5
Rosie	10												Shelf	17	7.0
Slide	25												Sliderock	17	7.0
Washington	13												Snow	21	7.0
													UpWell		7.0
													Waterdog	93	9.2
													Willow	35	7.7
Average	24		73		36		27	7.4	6	18	0	9.0		37	7.2

*This data collected with use of Hach equipment, therefore, these are only ballpark estimates and accuracy cannot be depended upon

Table 24

Comparison of Hydrochemistry Data
Between the White Clouds, Boulders, and Pioneers Lakes

Area	Turb	TDS	Cu	Fe	Mo	Hd	Alk	Cl	Na	NO_3	PO_4	SO_4	TS	pH	Number of Lakes	Phen Alk	Free Acidity	Total Acidity	Free Car. Diox.	Free Oxygen
White Clouds	<25	27	.030			23	27	-	-	0.7	0.4	-	-	-	14	-				-
White Clouds	<25	23	.005	.03	<.01	21	9	-	1	.29	<.01	1	35	-	35	-				-
White Clouds (Big Boulder)	<25	-	-	-	-	27	18	-	-	-	-	-	-	7.4	13	-				9.0
White Clouds (Little Boulder)	<25	-	-	-	-	37	-	-	-	-	-	-	-	7.2	20	-				-
Boulders	<25					67	65	-	-	-	-	-	-	8.6	21	6.1	0	5.0	5.4	9.0
Pioneers	<25	-	-	-	-	35	31	-	-	-	-	-	-	8.4	9	9	0	2.0	3	9.9
White Clouds (Germania)	<25	-	-	-	-	24	-	-	-	-	-	-	-	-	17	-	-	-	-	-
White Clouds (Champion)	<25	-	-	-	-	73	-	-	-	-	-	-	-	-	7	-	-	-	-	-
White Clouds (Fourth July)	<25	-	-	-	-	36	-	-	-	-	-	-	-	-	10	-	-	-	-	-

However, it is believed that the waters in the White Cloud Lakes will prove to be more fertile than those in the Sawtooth Lakes. Within the White Cloud Area, the Little Boulder drainage lakes are the least fertile, if Big and Little Frog Lakes are not considered. Big and Little Frog Lakes are very fertile in relationship to the other lakes. Lakes in the White Clouds tested for total phosphorus and total nitrogen are found to be very low, which also indicates they could also be lacking in trace elements.

Low fertility in the Little Boulder drainage is probably the primary reason the majority of the lakes are supporting stunted trout populations.

Very seldom does a lake have any turbidity or unnatural color. This is due to aquifers composed mainly of rock and soil positions of the watershed in good condition, plus the large water retention time in most lakes. Both total solids and total dissolved solids rank very low, which gives the lakes very little to work with in producing an organic product. However, to a degree, this is good, as it gives the waters the pristine condition so valued in today's degradation of lower elevation waters. These waters are very valuable for offsite fisheries.

It is very feasible to upgrade the fertility of the White Cloud Lake systems by treating just the upper lake with trace nutrients and letting them filter down through the system. This would increase the fish production in the area but could have degrading effects in lower river systems and impoundments where overfertility is already a problem. It would take some intensive studies to determine if this was a beneficial procedure or not.

Table 25

Summary of Lake Hydrochemistry in the White Cloud Area in about 1937 by A. W. Klotz

Lake	Test					
	TS	Loss Ign	Res Ign	Alk	Hd	pH
Chamberlin (Upper)	62	20	42	26	30	7.8
Champion (Upper)	122	34	88	73	78	7.7
Champion (Lower)	126	34	02	54	80	7.5
Washington	60	26	34	21	30	6.9

Fluvial Habitat

Two major river systems and their tributaries drain the White Clouds, and, in doing so, provide high quality anadromous and resident fisheries. The drainages, except for some streams having suffered (Slate and Big Boulder) overpowering energies from 25- to 100-year storms, are in excellent condition. Mining activities have been detrimental to Big Boulder, Slate, and, to a very minor extent, Little Boulder Creek. Within the study area, the most artificial factor destroying the fluvial aquatic habitat would be grazing activities. Low gradient streambanks within grazed areas are in poor condition, as demonstrated by the Little Boulder Creek stream inventory. A stream condition map appears in the White Cloud, Boulder, Pioneer aquatic environment studies.

East Fork Salmon River and Tributaries

The East Fork Salmon River is utilized by both spring and summer chinook salmon for spawning and rearing purposes. Summer chinook spawn in the lower reaches. Both species are in danger in the Columbia River system, and summer chinook are approaching the endangered status.

Considerable spawning takes place in Herd Creek, and scattered salmon spawning takes place in the lower end of many of the tributaries. Steelhead trout spawning is scattered throughout the whole system. Little is known about the steelhead population. The bulk of the salmon spawning takes place above Herd Creek on the East Fork Salmon River.

The chinook redd counts on the East Fork during the 7-year period (1963-1969) averaged 11.4 percent of the total redd counts in the Salmon River drainage (Table 26) and provided about 6 percent of the Statewide chinook harvest in recent years.

Table 26

Chinook Salmon Redd Counts Within the Study Area
in the Salmon and East Fork Salmon Rivers

ream	1960 **	1961 **	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
lmon*	1,471	1,133	653	638	706	472	699	943	637	313	432	619
F. Salmon	1,125	1,177	578	911	711	269	727	848	857	312	591	519
rd Creek	-	283	58	202	49	31	79	32	57	43	47	49
lmon Drainage	9,472	9,581	8,592	7,287	8,193	4,298	7,127	7,444	6,531	3,962	4,442	3,883

almon River from Redfish Lake Creek upstream.
Includes the complete Main Salmon River.

The capitalized value of the East Fork Salmon River fisheries at 4 3/4 percent lies within a low of $6,258,947 and a high of $12,890,526 (Mallet). It is a very valuable resource; and, if the aquatic environment was altered to the point that it has been in other anadromous waters (Blackbird-Panther Creek), there would be great economic loss.

Much of the watershed for the East Fork Salmon River lies within the White Cloud-Boulder study area. The average discharge is about 200 c.f.s. The maximum discharge recorded was 3,580 c.f.s. and the minimum was 29 c.f.s. There is a total of 30 irrigation diversions on the main stem and numerous ones in the tributaries. Over half of the diversions on the main stem have been screened to return downstream moving young salmon and steelhead, but still the diversions of the waters at a time when the aquatic environment is entering critical periods is detrimental to the fishery.

<u>Warm Springs Creek</u>

Warm Springs Creek is 23 miles in length with a mean discharge of about 120 c.f.s. The stream gradient in the lower 10 miles is extremely steep. Because

of this steep gradient (cascades and falls), it apparently keeps salmon and steelhead from ascending into the upper Big Meadow area (Warm Springs Meadow). Some salmon redds are counted in the lower stretch of the stream near Robinson Bar. Salmon do spawn above Garland Creek. A waterfall about 7 miles up near the mouth of Bear Lake Creek would be a complete barrier. The Warm Springs Meadow area, because of its low stream gradient and high quality meandering-type aquatic environment, supports an excellent fishery. This could also offer an excellent salmon and steelhead spawning area, if access were available. The only land use affecting the aquatic environment is the heavy streambank livestock grazing activity in the meadow areas.

Little Boulder Creek

Little Boulder Creek has gained in reputation because its headwaters contain the mining activity that brought the White Cloud area into national prominence It is a fairly steep gradient stream, but does have a couple of good control or knickpoints that by accumulation of depositional materials have created some excellent aquatic habitat. The stream has high streamflows exceeding 200 c.f.s. on a recurrence interval of 2.3 years and exceeding 440 c.f.s. on a recurrence interval of 50 years. These high natural energy flows coupled with low base flow tied to critical winter conditions limit the ability of almost all the streams in the study area in their ability to produce fish. This stream, as most high mountain streams, lacks pools. It is predominately a boulder-rubble type environment with very little fines. Streambanks are in very good condition, except those areas degraded by livestock grazing.

Table 27

A Summary of Aquatic Habitat Survey Data
for Little Boulder Creek, August 1969

Stream (Feet)			Pool		Streambed Surface Composition (Percent)				Banks		
Width	Depth	Riffle	Width	Rating	Boulder	Rubble	Gravel	Fines	Cover	Condition	Type
16	9	11	4	2.8	39	26	34	01	1.7	1.6	1.5

Little Boulder is of little value to the anadromous fishery (except to contribute water to downstream areas) but does have a fair resident fishery made up mainly of rainbow, cutthroat, and Dolly Varden trout. Stream areas running through meadows have been damaged by livestock activities.

Big Boulder Creek

Big Boulder Creek is quite similar to Little Boulder Creek, except the lower portion has been affected by land uses. It also is a boulder-rubble type environment and is being held back as a fishery because of a lack of pools. Pools that do exist are fairly low in quality. The amount of fines within the system (contained) is low. Streambanks are not in as good a condition as they are in Little Boulder Creek. This stream is showing the scars of having received too much stress from the surroundings.

Table 28

A Summary of Aquatic Habitat Survey Data
for Big Boulder Creek

Stream (Feet)			Pool		Streambed Surface Composition (Percent)				Banks		
Width	Depth	Riffle	Width	Rating	Boulder	Rubble	Gravel	Fines	Cover	Condition	Type
21	11	17	3	3.5	42	23	28	07	1.3	.9	1.4

Mining activities, plus mine road encroachment, have disturbed stream channels and increased sediment rates and turbidities in the lower 7 miles of stream. Mine tailing ponds, not now in use, still bleed their fine and toxic materials into the stream during rains, snowmelt, or high water conditions.

Big Boulder Creek has received some blowout damages from a couple of side tributaries that have caused streambottom and streambank problems.

Slate Creek

Slate Creek got hit with a high intensity storm in 1963, and it is in extremely poor shape. Very little work has been done to study this stream other than document and monitor hydrochemical data.

It does have considerable mining activity and two mills are operated intermittently. A road parallels most of its route and major tributaries. Although the aquatic environment is being disturbed by land uses, it is overshadowed by natural climatic events.

Hydrochemistry

Lakes contain, and to some extent change, the hydrochemistry of the streams that drain them. Stream hydrochemistry is more a dynamic type, as compared to the static conditions found within the lake systems. Streams within the area are more affected than lakes by land uses, such as mining, grazing, and road building. Streams have very critical winter conditions like the lakes, but from different factors. Lakes kill out mainly due to oxygen deficiencies, toxic gaseous buildup, and water displacement. Streams kill out mainly due to temperatures, energy flows, and, to a lesser extent, water displacement.

Some extensive hydrochemistry data has been done on some of the streams draining the White Clouds due to past and future effects from mining operations. To date, no toxic effects from mining operations, other than increased sediment rates, have been detected.

If mills continue to operate in Big Boulder and Slate Creek drainages with present pollution abatement systems, a buildup of toxic materials could show. Monitoring studies have been conducted on six of the streams, in cooperation with the Idaho State Health Department, to place us in position to pinpoint changes should they develop.

The Slate Creek drainage is quite fertile, as compared to the Big and Little Boulder Creek drainages. Little Boulder Creek is slightly less fertile than Big Boulder Creek, which is undoubtedly due to differences in parent materials within their respective drainages.

The hydrochemistry profiles of the streams do lend themselves to good salmonoid habitat, being neither too fertile nor too sterile. Due to continual mixing with atmospheric gases, the dissolved oxygen content of the streams appear to be near saturation at all times. Unlike lakes, this does not present a limiting problem.

Table 29

Comparison of Hydrochemistry Data
Between Streams in the White Cloud Study Area
(1967-1970) in ppm and units

Stream	Test																									
	Hd	Alk	TS	TDS	Cu	Fe	Ag	pH	Ca	Mg	O	Mn	Na	Al	Cl	S	SO_4	NO_3	PO_4	F	Pb	Zn	Turb	Mo	TU	JU	Number of Samples
Slate	101	77	195	175	.02	.04	.02	8.1	21	7	-	.34	2	-	<2	-	19	.9	.05	.32	.15	.387	<25	<.01	<5	<25	36
Basin	45	-	70	62	.02	.23	-	7.5	19	1.7	-	.014	6.5	-	4.5	-	5.8	-	.03	.29	.09	-	25	-	<5	7	25
Big Boulder	77	-	128	121	<.01	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<.01	25	<.01	<5	<25	82
Little Boulder	72	53	125	106	<.01	.02	-	-	-	-	9.5	-	0.3	<.01	27	.4	-	-	-	-	-	<.01	<25	<.01	-	<25	64
Silver Rule	113	104	215	169	.01	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	<25	.01	-	<25	5
Carbonate	88	80	126	122	.01	.06	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	<25	<.01	-	<25	5

Boulder Area

Because of its proximity to Sun Valley and good access to the major streams via U. S. Highway 93, the stream and lake areas are very popular and heavily used. Big Wood River is the principal stream and drains the designated area. Although it still produces a fair trout fishery, Big Wood River has been greatly degraded in recent years. Natural reproduction has been reduced and the fishery is quite dependent on put-and-take fishing. Stocking records show that between October 1969 and September 1970, about 1 year, a total of 79,270 trout, weighing 22,680 pounds, were stocked in Big Wood River. Even if natural reproduction were upgraded, it could not supplement this magnitude of need by the recreationist. Reclaiming degraded stream areas and improvement on tributary streams would increase native trout populations.

The larger streams drain more fertile watersheds than found in most of the SNRA. The lakes also are more fertile than surrounding areas, such as the Sawtooths and White Clouds.

Lacustrine Environment

Most of the high mountain lakes have been stocked with trout, but few of them successfully. Because of the lower elevations, less glacial activity, and depositional materials from continual snowslides, the Boulder Area does not have a good lake type environment. Lakes that do support a fishery get very heavy fishing pressure. The Idaho Fish and Game Department has stocked Big Lost Lake with grayling, which were doing quite well in 1971.

Some lakes, such as Titus, are close to the needed conditions to support a continual fishery but lack the complete requirements. Titus does support a good fishery, but kills out under certain conditions. Usually, it is depth because the glacial action did not have the energies to dig deep pockets or push large amounts of debris to build large dams.

The lakes surveyed during the summer field season were quite saturated with dissolved oxygen. However, due to the limited dissolved oxygen contained at time of freezeup, plus the winter buildup of free carbon dioxide and other gases, these are probably the most critical conditions for fish survival. Snow and ice replacement of the liquid water, however, is another critical item. There is very little good lake and reservoir-type environment available, and, therefore, streams support almost all the fishing use. This area needs more water-orientated recreation, and one way to obtain it is to form artificial environments and enhance and protect existing environments.

Fluvial Environment

Fertile waters, perennial flows, and low gradient meandering streams offer some good aquatic environment in the Boulder Study Area. Streams that have been documented as to aquatic environment conditions will be discussed separately.

Big Wood River

Most of the degradation of Big Wood River was directly due to poor land use practices such as highway construction and overuse of stock driveways. Prior to 1965, as many as 175,000 sheep were driven over the Ketchum-Stanley stock driveway each spring and fall. This concentrated use resulted in

extensive erosion problems which added to the sediment load in the river already increased by road construction. The Ketchum Ranger District has done a commendable job in eliminating this problem and almost totally reducing the stress on the river from this cause. In 1965, use of the driveway was limited to the fall and the number of sheep was reduced to between 15 and 20 thousand. The eroded areas were rehabilitated and now much more stable.

When the new highway was built between Ketchum and Stanley in the late 1950's, several sections of stream were channeled and relocated. This channelization resulted in the direct destruction of approximately 1 mile of stream. By cutting out many meanders the gradient was made steeper, thereby greatly increasing downstream water velocity. The accelerated velocity and changes in energy direction has created severe bank erosion in several areas, therefore, much more than the originally altered mile has been adversely affected.

An example of an unstable stretch is near the mouth of Silver Creek. Several gabions have been installed, but there is still a lot of bank erosion on the bend above the Silver Creek bridge. Unless this bend is stabilized, the river will soon alter its course sufficiently to wash out the bridge and cause further sedimentation problems.

Big Wood River above the confluence with Horse Creek is too small to consider as a fishery. From Horse Creek to about ½ mile below Galena Store there are four channeled stretches which could be considered for habitat improvement. The banks are quite stable except for the last channeled section. Due

to the artificial conditions, there are very few pools or resting areas for fish. From Galena to the Prairie Creek bridge, the river is generally very good habitat (other than channeled section) and receives quite heavy angling pressure. This section contains natural meanders, deep sheltered pools, and well vegetated, stable banks.

Between Prairie Creek and Easley Campground, the river is relatively straight and swift with few large pools. The substrate is well scoured, large rubble and boulder with many shifting gravel bars. Two sections were channeled in this area--a large section above Silver Creek and a shorter one above the highway bridge at Easley. From Easley to the mouth of Coulder Creek, the fishery habitat is very good with many large, deep pools and generally stable, vegetated banks. Many trout were observed through this section.

The Boulder flat section has a lower gradient and consequently is an area of deposition of sand and gravel. The river channel has changed many times here and the banks are mostly bare, sloping gravel bars. There are several small stretches in this area that afford good trout habitat, but as a whole this section can only be considered fair as a fishery. From Wood River Campground to North Fork the river is quite straight and swift with a predominately boulder-rubble substrate. The banks are stable and well vegetated, but there are few pools or resting places for trout. From North Fork to Lake Creek much of the land along the Big Wood is privately owned, most of which has been subdivided for summer home sites. The habitat along this stretch has been greatly degraded by channel alterations and riprapping to protect the homes from high water. A great deal more construction is

anticipated in this area in the near future, and unless a buffer zone is established along the bank and heavy equipment kept out of the stream, the habitat along this entire section could be completely destroyed.

In 1968, 1969, and 1970, the Boy Scouts under the direction of Clair Baldwin, Ketchum Ranger District, undertook a stream improvement project in Horse Creek just above the confluence with the Big Wood River. This was a straight artificial section of relocated stream with high current velocity, unstable banks, and no suitable trout habitat. The Scouts installed K-dams approximately every 100 feet, which produced a stairstep effect. This reduced velocity, produced fair pools, helped the banks to vegetate and stabilize thereby improving habitat quality. Trout are now present in all of these pools. There are other areas within the Big Wood River drainage that fit the requirements for stream rehabilitation. The waters of Big Wood River are used for irrigation, and some areas below the study area are completely diverted (dried up) during irrigation.

The Federal Bureau of Reclamation has investigated the possibilities of building a large holdover storage reservoir on Big Wood River that could, <u>under proper management</u>, alleviate some of the critical aquatic environment conditions that now exist. The Boulder Flats damsite is located in Blaine County within the Sawtooth National Forest boundary 2½ miles above the confluence of Big Wood River and the North Fork Big Wood River. It is mainly a single purpose reservoir to serve the functions of irrigation, but does have added value for flood control and recreation. The dam will be 292 feet in height and drain a 137 square mile watershed. The full elevation water level will be about 6,500 feet above mean sea level.

The purpose of the reservoir would be for providing supplemental water to lands in the upper Big Wood River Valley. The impoundment (Boulder Flats), located 10 miles above Ketchum, Idaho, in Blaine County, would have an active capacity of 195,000 acre-feet, containing 3,700 surface acres forming a reservoir at full stage about 5 miles long and about ½ mile in average width. It is understood an attempt will be made to keep the reservoir above the 100,000 acre-foot level.

The proposed impoundment would eliminate 7 miles of excellent trout fishing streams, which is estimated (1967) to support annually about 750 fishermen days, harvesting approximately 3,500 game fish, with an annual fishery resource value of $22,950. The impoundment could, under proper management, promote better fish growth, better survival, more favorable water temperature, enhance streamflows in downstream areas, and possibly eliminate the need for future downstream channel changes by the U. S. Army Corps of Engineers.

It is possible that the high dam (292 feet and storing 195,000 acre-feet) discussed may be withdrawn as a proposal. Instead, it is possible a 180-foot dam that would store 90,000 acre-feet may be proposed. This lower dam would only inundate approximately 4 miles of Big Wood River as compared to 7 miles by the higher dam. If this dam was constructed, it would supposedly be mainly for recreation and flood control. It would have a proposed drawdown only to the 30,000 acre-foot level, leaving an excellent conservation pool. Also, it would not be drawn down until after the summer recreation season was over. Assuming this plan is followed, the lower dam could enhance the value of the fishery considerably.

Stream channel changes, alignment, and encroachment by roads and homes have eliminated or degraded large areas of the stream. Road construction alone, through stream alignment in Upper Big Wood River, has eliminated almost 1 mile of stream. Many areas have been encroached further degrading the aquatic environment. Big Wood River is far from being the fishery it is capable of because of land use effects.

Baker Creek Drainage

Baker Creek originates on the eastern slopes of the Smoky Mountains and flows into the Big Wood River about 16 miles north of Ketchum. Only the lower position lies within the proposed SNRA.

The physical inventory included approximately 10 miles of stream, of which the lower 8 miles could be considered good fishery habitat. The entire length of Baker Creek is accessible by good gravel road. There is only one small section near the mouth of Boyer Gulch where the road is near enough to the creek to have some effect upon bank condition.

This drainage has no developed recreation sites, but because of its easy accessibility, is quite heavily utilized by campers and fishermen. Logging operations have been carried out in several tributary drainages of Baker Creek--Newman Creek, East Fork of Baker Creek; Norton, Apollo, Brodie Creeks--and in the upper portion of Main Baker Creek. Although there were several large clear cuts on steep terrain, the roads and skid trails are very stable and do not appear to be adding to the sediment load of the stream. Some bank damage has occurred from sheep grazing in the meadow section near the mouths of Alden Gulch and South Fork of Baker Creek.

In general, Baker Creek appears to be in good condition and would support a substantial population of trout. The only real unstable portion is that ¼-mile stretch immediately below the mouth of Norton Creek. This is primarily due to the heavy spring runoff from the Norton drainage. There are no records of planting Baker Creek in the Idaho Fish and Game Department stocking reports, but a few trout were observed in most sections.

Prairie Creek Drainage

Prairie Creek originates as the outlet of a series of shallow mountain lakes on the north slopes of the Smoky Mountains. Approximately 6½ miles of stream exist between Prairie Lake and the confluence with the Big Wood River.

Although a few small trout (4" to 6") were observed in a few pools in the upper meadows, the upper 4 miles of stream are too small and shallow to support a worthwhile fish population. There is considerable evidence of scouring by high spring runoff and winter ice. This ice formation combined with shading by deep snow would probably lead to extensive winterkills. The lower portion, below the confluence with West Fork of Prairie Creek, appears large enough to support a fishery. The section of stream between Mill Creek and the end of the road contains excellent habitat. Below Mill Creek, the stream is quite straight and swift, the banks are generally quite stable, but there are very few pools or resting spots for trout.

Hydrochemistry

The Boulder Study Area contained, overall, the most fertile water samples. The lake systems are much harder, have more total solids to work with, and are quite basic as compared to the White Cloud and Sawtooth Study Area. The

water lends itself very well to the production of a favorable fishery product. With total solids over 175 p.p.m., total dissolved solids over 135, and both hardness and alkalinity over 100, the biotic communities have the necessary inorganics to build the food chain.

ENVIRONMENTS AND FISHERIES BY LAND TYPES

Depositional Lands

Description

The depositional lands are adjacent to and include the main stream channels. Although less in area than some of the other land types, they contain the most important areas of the fluvial environment found within the proposed SNRA. Most of the salmon spawning and rearing takes place within this type. Steelhead also are found utilizing this type more than all the other types combined.

This area includes very little lacustrine environment, but the streams are the most optimum and productive of the aquatic habitat types found. The fluvial habitat lends itself to heavy recreation use with easy access. Because of its great importance and being the most heavily used of the fluvial environments by the recreationist, it is rated very high as a resource and needs constant protection.

The main river and its side tributaries are in almost natural conditions. There are some man-caused stresses causing degradation which is discussed under evaluation. The fluvial environment is almost in excellent condition as far as streambed materials. The 4 percent fines found within the main system is probably quite close to natural conditions, and the resource activities to date have had only a small effect on this physical condition. The fluvial environments are mainly a rubble type environment with sufficient gravel areas for spawning. Streambank cover, condition and type rate good and are not in excellent condition. High quality pools and number of pools per mile is lacking, but this is natural in this type environment.

The fluvial environment is low in fertility due to the predominance of upstream granitic watersheds. This low fertility results in immature systems low in organic energy and well suited to the needs of salmon and steelhead to convert from a low number adult population to a high number juvenile progeny population.

The fish species composition contains nongame fish which are not in demand by the recreationist. With a portion of the existing fish production in an undesirable product, there is a dampening effect on the desirable species. The streams are low gradient, low energy streams, when compared to the streams in the other land types. Due to the lower energy levels per unit area, they are more capable of developing a more productive stream environment for the salmonoid species.

Evaluation

The Salmon River is one of the few rivers remaining that is unused as a water storage system and flows fairly near the natural state. Highway construction, especially between Stanley and Clayton has dumped considerable debris in the river and created false banks. The streams and rivers do, however, have many water diversions due to constant diversion for irrigation which is degrading the aquatic environment. Under the present water management plans, both upstream and downstream salmon, steelhead, and trout are faced with movement restriction, migration blocks, and loss of desirable habitat. Most of these diversions are not screened to prevent salmonoids from being left in the field. Water diversions cause critical low water conditions at a time when the aquifer is only capable of releasing low flow conditions. These diversions exist on

both private and public lands and are used for irrigation purposes from about July 1 through about September 15.

Streambank cover, condition, and type are rated good. Lack of vegetative cover plus damage from livestock grazing keep the streambank from having an excellent rating.

The irrigation season coincides with part of the low waterflow period, so that it is necessary on certain diversions to divert the complete streamflow in order to provide the irrigation demand. The irrigation season, and subsequent stream diversions, coincides with the upriver migration of anadromous salmonoids to their spawning locations and during these spawning periods.

Many of the streams (especially the main river and some major tributaries) are stocked by the Idaho Fish and Game Department and vehicle access is needed by the fish transporting system so fish distribution will be adequate. The fish species composition within the heavier used fishing areas contains undesirable and/or forage fish which are not in demand by the recreationist. These species need to be controlled as to composition so a quality fishery is available to the recreationist. If private acreage now under irrigation could be placed under public ownership as nonirrigable lands and Federal lands now presently irrigated returned to natural conditions, the aquatic resources would be greatly enhanced. Diversions need to pass fish and release minimum flows and also be screened to eliminate fish loss.

The drainage of marshes within the area degrades the aquatic environment by lower water levels, eliminating ponds and streams which, in turn, degrade the fisheries. If these wetlands were restored, it would greatly benefit the wildlife-fisheries resource.

Much of the stream area within this land type run through private lands. Public access has not been assured for the future. If the aquatic resources are to be utilized fully, they must be readily available to the public.

Livestock grazing occurs on most of the streambanks and this is degrading the aquatic environment by sediment addition, increasing water temperatures, decreasing cover and food supply, and in turn, decreasing carrying capacity.

Sawtooth Moraine Lands

Description

Within the Sawtooth Valley moraine lands are found the larger lakes. Most of these large lakes have road access and, in turn, receive heavy recreation use. Due to their infertility and species composition, these lakes are not good fisheries. Even though they are very large (relative to lakes in other land types) with deep depths, they only produce a small native game fishery. The hatchery product stocked in these lakes contributes heavily to the fishery.

These lakes in their pristine condition are the main attraction of the area as the sportsmen tends to relate to the water environment. Hydrochemical data demonstrates the low fertility, high clarity, and low water temperatures that cause the pristine characteristics.

The lake waters are low in dissolved chemicals and organic and inorganic materials. They are, however, more fertile (dissolved solids-wise) than most of the lakes in the glaciated and strongly glaciated areas. On the larger lakes, however, like Redfish, Stanley, Alturas, etc., their deep average depths eliminate the bottom from contributing to the productivity. Streams within this area have increased in gradient over those in the depositional lands, but much less than those found in the remainder of the

land types. The streams offer relatively good habitat. They are mainly rubble-gravel environments, but usually too small for salmon to utilize for spawning. Young salmon move into the lower end of some of these streams to rear when migration blocks do not keep them out.

Evaluation

The main environments within this land type are the larger lake systems which are receiving heavy use by the recreationist. However, due to lack of fertility, deep depths, and a large ration of nongame fish to game fish, these lakes are not rated as good fisheries. It takes a hatchery supplement each year to keep them in a fishery.

Because of the large size of some of these lakes, it is difficult to manipulate the environment or the biotic community to enhance the fishery. However, a few of these lakes (Pettit, Yellow Belly, and Stanley) have been chemically treated and restocked with salmonoids. Perkins Lake was treated with "Squoxin" which killed only squawfish. In the future it will be necessary for the Idaho Fish and Game Department to be able to control species composition to enhance the fisheries.

The drainages have high and low streamflow regimen which results in two annual, critical periods in both the lake and stream environment which govern fish growth and survival. One critical period comes during high peak flows in combination with increased energy flows and abrasive or suffocating materials. The second, and often more critical period, is during low flow conditions which are sometimes coupled with winter ice and snow effects.

Streams flowing through this area have generally changed to a lower gradient, slower velocity type environment than those found within land type in their headwater areas. Due to this lower gradient and lower energy flows, they offer better habitat than the upstream areas.

Roads have more negative impact in the land type than in all the other land types other than the mountain slope lands. As in other land type trails, wildlife grazing, recreation use, and fire have insignificant effect on the fisheries. However, because in this land type, gradients have increased over those found in the depositional lands plus stream areas getting tighter, mining and logging operations can have more negative impact. There is very little stream diversion or irrigation within the area as found in the depositional lands.

The resident trouts are the main species found, although the lower end of some streams are utilized by salmon and steelhead for both spawning and rearing.

Strongly Glaciated Lands

Description

The strongly glaciated lands have the least species diversity. This is due in part to the predominance of lacustrine habitat and poor fluvial environment, but mainly to the extreme climatic conditions. This area is typified by long cold ice-and-snow producing winters with a short summer. The growing season is very short. Restricted access to fish has also kept species diversity down. Prior to the coming of the white man, most of the aquatic environments were barren of fish life due to restricted access caused after the last glaciation period swept the area fairly clean of fish life.

The fisheries are composed mainly of rainbow and cutthroat trout. In recent years, other species have been added such as brook trout, California golden trout, and grayling. The harshness of the climate restricts the number and kinds of species that can adjust to the cold, alpine conditions.

The complete proposed Sawtooth National Recreation Area is relatively infertile as far as hydrochemistry is concerned. The strongly glaciated lands are the most infertile of all with very low biomass per unit area. The area takes in the headwaters where waters have had less time and chance to dissolve nutrients from the parent materials.

In the strongly glaciated land type, snow and ice leave slowly in the spring and return early in the fall. High flows occur from May through June and low flows from August through April. Usually, by mid-July, good fishery conditions have developed which last until freezeup in October or November. The short, ice-free conditions make the available fishing period very short in the majority of the area.

A fundamental characteristic of these high elevation waters is the relatively short summer season, while over the rest of the year generally severe conditions prevail with low temperatures, floods, ice, and snow. Snowslides or long periods of deep snow cover can completely kill out a fish population in small streams, shallower lakes, and, on some occasions, in deeper lakes--thus making the lake or stream barren. A well-populated lake one year may be a desert the next year, as far as fish life is concerned. Climatic conditions change from year to year so that there is great variability in the processes acting upon the environment.

Streams are rapid flowing, high velocity, with steep gradients. Because of this extreme high energy, harsh climatic conditions, and large fluctuations, they have little to offer as a fishery. Even those streams tributary to the lake systems often are too steep to offer spawning or rearing opportunities to the lacustrine fish populations.

Evaluation

Although access is difficult, this area has been receiving constantly increasing use due to not only its pristine desirability, but its national prominance. Because these are low energy systems (lakes and streams) they cannot stand up under heavy fishing pressure. They are also delicate systems with little buffer potential and stresses from the surroundings show immediate effects.

This land type contains an abundance of high mountain lakes that contain portions of the surface flow allowing a longer use of these waters before they leave the area. Because most of the lakes lie in granitic basins with the aquifers also draining mainly granitic materials which are quite water insoluable and low in nutrients, the lakes are almost always low in mineral content. In very few environments would you find lake waters so close to the rain water characteristic. Due to this factor, they have a low production of biomass per unit area which in turn lowers fish growth and survival.

These lakes must, due to the harsh climate, contain or add enough dissolved oxygen during the freezeup period to take care of the biomass. During this freezeup period, many lakes will freeze to the bottom or use up their dissolved oxygen killing the fish population it may contain. Other lakes will go dry

during late summer and fall periods due to lack of water volume, lack of incoming water, or permeable basins.

Although this land type is dominated by harsh conditions, it is tough in relation to certain land uses. Roads can be built into the area without causing heavy sedimentation problems due to the almost total rock-type soils. Logging can also be done without heavy sedimentation due to the soils and rock types being less affected by surface waters. Trails, wildlife grazing, recreation use, fire, and most special uses would have very little negative impact on the fishery. Recreation could have serious impact if it built up to the point that areas are constantly overfished. However, there are means to control this type of use.

Mining and grazing do and will have serious impacts because these immature systems have little buffering ability. Grazing in high cirque meadows can be very damaging to the small streams and adds nutrients to the lake waters that may not be wanted.

The dominant species are rainbow, cutthroat, and brook trout. These species are very well adapted to these cold environments.

Anadromous fish do not penetrate the area, although the high quality waters leaving this area are of great benefit lower down in their spawning and rearing areas.

Glaciated and Granitic Glaciated Lands

Description

This area contains mainly stream areas that are intermediate between the strongly glaciated lands and the mountain slope or moraine lands. Lakes that

do occur within this area are generally more fertile than those in the strongly glaciated land types. Streams also contain more favorable habitat than the strongly glaciated area as they have decreased in gradient and added waterflow.

There is very little difference between the two land types, as far as fisheries. The environments in the glaciated lands and the glaciated granitic lands is very similar and there is no need to discuss each separately.

The main fish species composition is made up mainly of rainbow, cutthroat and brook trout. Unlike the strongly glaciated lands, the streams are now starting to support populations of other fish species such as whitefish and suckers, but not near to the extent as found in the depositional lands.

Anadromous salmon use the lower elevation streams to a small extent, but the bulk of it is either inaccessible to them or not desirable. Steelhead would use the areas, as they tend to spawn further updrainage than salmon.

Almost all the streams and lakes are in natural conditions. A few such as Slate and Big Boulder have been degraded, but due to natural blowouts.

Evaluation

Because these land types occur below the elevation where glaciers could have much success building cirque basins, the area does not offer much lacustrine environment. Streams still being in the harsh climatic area, plus fairly high gradients also do not usually contain a good fishery environment. As a result, the area does not have heavily utilized fisheries or produce much into the fishery. The bulk of the fishing takes place in the depositional,

moraine and strongly glaciated lands. About the only exceptions to this is that the upper end of Redfish Lake and a large part of Alturas Lake fall within this land type. However, these lakes were built due to the morainal processes found in the Sawtooth moraine land type.

These land types are fairly tough when compared to the mountain slope lands. Road construction and logging, when done properly, would only have a small effect on the aquatic environment. Trails, wildlife grazing, recreation use, and fire would have insignificant effect. Because these land types produce and transport water to the lower more productive fisheries, mining, waste disposal effluents, and irrigation influences are and could be very detrimental to the aquatic environment. Livestock grazing within the area, especially the meadow areas, is very degrading to streambank conditions.

Challis, Granitic, and Wood River Mountain Slope Lands

Description

The lacustrine environment is almost insignificant except for beaver activity. Those lacustrine environments that do exist, however, such as Jimmy Smith and Sullivan Lakes are the most productive of the lake type environments and are very close to Frog Lake in productivity. Sullivan Lake could be an excellent fishery if it were artificially increased in volume.

Salmon utilize the lower stream areas to a minor extent for spawning and rearing such as Warm Springs Creek and Big Casino. Steelhead would utilize more of the area. If we consider the Main Salmon River as flowing through this area from lower Stanley to Clayton, it does include some very important salmon and steelhead areas.

The streams, like the few lakes that do exist, are the most productive ones found within the proposed SNRA, hydrochemistry wise. They normally do not have the low gradient found in streams in the depositional lands, which under conditions found add greatly to productivity in the depositional lands. However, they do have some productive fisheries.

Streamwise, these lands do not produce very large streams. Most of them are too small to support good fisheries. There are exceptions such as Warm Springs Creek and the upper end of the North Fork Boise River. The remainder of the streams, however, are not good fisheries due mainly to the small size. By the time streams in this area do develop to a size needed, they enter a depositional land type or enter another stream lying in another land type.

Game fish species are mainly rainbow, cutthroat, and Dolly Varden trout. Forage and undesirable fish are present, but like the game fish, due to the bulk of it being undesirable habitat, their populations are usually low.

Evaluation

The mountain slope lands, as far as the aquatic environment is concerned, are the tenderest lands within the proposed SNRA. Stream channels are usually in direct contact with valley sides and very little buffer zone is available as found in the glaciated and depositional land types. Road construction and maintenance has much more impact in these lands due to the soil types, gradients, and lack of buffer zones. Also, because of the tight stream-cut valleys, encroachment from roads is usually more severe, plus the construction and annual maintenance effects are more direct.

The streams within this area drain directly into the most optimum of the aquatic habitat types found, therefore, their condition can determine downstream conditions.

Logging within this land type is rated the highest as far as having a potential for degrading effects on the environment. Again, like road construction, the soils and steep gradients and tight canyons form delicate conditions.

The Main Salmon River, bordered from lower Stanley almost to Clayton by this land type is a very important area for summer chinook spawning and rearing of both spring chinook and steelhead. Again, like the tributary streams, the canyon walls grade directly into the stream and impacts on the watershed can be quite direct into the river.

Mining and milling again would be quite degrading if done improperly. Mill sites and tailing pond locations are critical because the V-shaped stream valleys give little room to work. In the past, tailing ponds in this land type have mainly met with failure and the aquatic environment has suffered.

Grazing by domestic livestock is and can be detrimental to streambanks. The land type with very little streambottom tends to concentrate livestock on the streams.

Trails, trail cycles, wildlife grazing, recreation use, and fire would have little effect on the aquatic environment. Waste disposal systems, however, need critical attention as the effluents would pass directly onto the prime habitat areas.

Hydrochemistry

Hydrochemistry has been worked into the individual study areas as needed. Because there is a considerable amount of hydrochemistry data available, it should be readily available for present fishery interpretation and for future work. There is still considerable hydrochemistry data that was not worked into this report, due to lack of time. The complete area within the proposed SNRA can be adequately described as to hydrochemistry oonditions as it relates to the aquatic environment and its resulting fishery resource. Enough data has been collected in waters in or moving from the designated land groups or land types to be able to describe the boundaries of the hydrosystems. This data can be compared to future work to determine if stresses to the system are moving it away from natural equilibrium. The data will be recorded in this section by drainage or by lake area so as to be readily available to the resource managers. For interpretation of this data, see discussions under the study area, drainage, or lake area.

WHITE CLOUD LAKES

Table 30

Chemical and Physical Analysis of Lacustrine Environments in the White Cloud Area (1969).

Lake	Test												
	TURB	TS	TDS	Fe	Mo	Na	SO4	NO3	PO4	Cu	Mo	Hd	Alk
pion (Lower)	<25	112	94	<.01	<.01	2	2	<.20	<.01	<.005	<.01		
t	<25	36	23	<.01	<.01	<1	2	<.01	<.01	<.005	.01		
	<25	24	9	<.01	<.01	<1	2	<.01	.01	<.005	.01		
ight	<25	48	33	.02	<.01	1	2	<.01	<.01	<.005	.01		
berlin	<25	44	29	.02	<.01	1	2	<.01	<.01	<.005	.02		
ier	<25	24	10	<.01	<.01	<1	1	<.01	<.01	<.005	.01		
	<25	72	44	<.01	<.01	1	4	<.01	<.01	<.005	.02		
ice	<25	20	10	<.01	<.01	<1	1	<.01	<.01	<.005	.04		
hire	25	24	10	.05	.01	1	2	<.01	.01	<.005	.01		
y	25	32	19	.04	.01	<1	2	<.01	.01	.005	.01		
on	<25	24	9	.03	<.01	1	2	<.01	<.01	<.005	<.01		
het	-	-	20	-	-	-	-	.22	.01	-	-	<20	8
wall	-	-	20	-	-	-	-	.30	<.01	-	-	<20	8
f	-	-	23	-	-	-	-	.63	.01	-	-	<20	4
ow	-	-	38	-	-	-	-	.52	.08	-	-	<20	12
epole	-	-	15	-	-	-	-	.63	<.01	-	-	<20	4
(Big)	-	-	60	-	-	-	-	1.34	<.01	-	-	20	24
low	-	-	15	-	-	-	-	.88	<.01	-	-	<20	8
erock	-	-	17	-	-	-	-	1.68	<.01	-	-	<20	8
	-	-	12	-	-	-	-	.30	.09	-	-	<20	8
p	-	-	12	-	-	-	-	.22	<.01	-	-	<20	4
(Little)	-	-	87	-	-	-	-	1.80	<.01	-	-	36	32
y	-	-	15	-	-	-	-	.44	<.01	-	-	<20	6
some	-	-	10	-	-	-	-	.52	<.01	-	-	<20	4
en	-	-	15	-	-	-	-	.44	<.01	-	-	<20	6
t	<25	28	15	.03	.01	1	1	<.01	<.01	<.005	<.01	-	-
ey	<25	28	17	.03	.01	<1	2	<.01	<.01	.005	<.01	-	-
Cup	<25	16	8	.06	.01	<1	2	<.01	<.01	.005	<.01	-	-
p	<25	36	21	.06	.01	1	2	<.01	<.01	<.005	.04	-	-
e	<25	40	27	.04	.01	1	2	<.01	<.01	<.005	<.01	-	-
	25	24	10	.04	<.01	<1	1	<.01	.01	<.005	<.01	-	-
der	<25	12	9	.02	<.01	1	<1	<.01	<.01	.005	.02	-	-
ll	<25	28	14	.10	.01	2	2	<.01	<.01	<.005	.03	-	-
Moon	<25	40	22	.04	<.01	2	5	<.01	<.01	<.005	.08	-	-
le	<25	28	13	<.01	<.01	1	<1	<.01	.01	<.005	.03	-	-
AGE	<25	35	23	.03	<.01	1	2	.29	<.01	<.005	.02	<20	9

Table 31

Chemical and Physical Analysis of Lacustrine Environments in the White Cloud Area (1968)

Lake	Test						
	TDS	NO_3	PO_4	Cu	Mo	Hd	Alk
Cove	28	1.4	.08	.040	-	<40	38
Island	17	1.4	.08	.090	-	<40	20
Walker	26	1.5	.06	.050	-	<40	30
Cirque	27	1.4	.06	.040		<40	30
Sapphire	29	1.4	.06	.020		<40	33
Born (Upper)	26	0.3	.03	.020		10	22
Born (Middle)	<25	1.3	.03	.030		<10	16
Born (Lower)	29	0.5	.03	.010		<10	18
Champion (Upper)	31	0.5	.01	.040		26	32
Champion (Middle)	29	0.5	.03	.010		14	24
Champion (Lower)	28	0.2	.02	.020		18	24
Phyllis	38	0.4	.04	.020		20	64
Washington	<25	0.1	.02	.010		<10	16
Fourth July	<25	0.2	.02	.030		<10	16
AVERAGE	27	0.7	.04	.030	-	23	27

Table 32

Chemical and Physical Analysis of Samples Collected in the Little Boulder Creek Drainage Lakes (1969).

	Lake	Test											
		TURB	TS	TDS	Cu	Fe	Mo	Hd	Alk	Cl	Al	Si	Na
69	Willow (in)		96	86				64	40	30	<.1	3	<1
	" (north)		92	83				60	44	27	<.1	3	2
	" (S. Drill)		160	142				72	52	23	<.1	4	4
69	Willow (in)		92	74				36	32	23	<.1	2	<1
	" (out)		96	83				48	40	32	<.1	3	2
	" (N. Drill)		116	102				60	68	34	<.1	5	8
	Castle (out)		134	113	<.01	<.01	<.01						
69	Willow (outlet)	<25	122	90	<.01	.14	<.01						
	" (inlet)	<25	120	107	<.01	.16	<.01						
	Hatchet (outlet)	<25	90	73	<.01	<01	<.01						
-69	Willow	<25	184	90	<.01	.03	<.01	—	—	—	—	—	—
AGE		<25	118	94	<.01	<.07	<.01	56	46	28	<.1	3	3

Table 33

Big Boulder Creek Station Locations

Station*	Location
1 BBC	Meadow 3/4 mile above mill
2 BBC	Immediately above Livingston Mill
3 BBC	Immediately below milling activity
4 BBC	Bridge crossing 3/4 mile above mouth
5 BBC	Just above mouth
6 ESC	East Fork Salmon River
7 BBC	Mouth of Jim Creek

Data are also available from May 27, 1970, through May 3, 1971, and will appear in the final White Cloud, Boulder, Pioneer, aquatic environment - fishery report.

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*Location documented on aerial photographs

Table 34

Chemical and Physical Analysis of Samples Collected in the Big Boulder Creek Drainage in 1969 (ppm and units)

Date	Station	Test					
		TURB	TS	TDS	Fe	Cu	Mo
10-21-69	1BBC	<25	106	98	.04	<.01	<.01
	2BBC	<25	106	98	.05	<.01	<.01
	3BBC	<25	120	102	.08	<.01	<.01
	4BBC	<25	116	113	.02	<.01	<.01
	5BBC	<25	130	111	<.01	<.01	<.01
	6BBC	<25	115	113	<.01	<.01	<.01
11-21-69	1BBC	<25	152	113	<.01	<.01	<.01
	2BBC	<25	100	98	<.01	<.01	<.01
	3BBC	<25	118	107	.02	<.01	<.01
	5BBC	<25	120	113	<.01	<.01	<.01
	6BBC	<25	150	118	<.01	<.01	<.01
Average		<25	121	107	.02	<.01	<.01

Table 35

Chemical and Physical Analysis of Samples Collected in the Big Boulder Creek Drainage in 1969-1970 (ppm and units).

Date	Station	TS	TDS	Hd	Fe*	Mo*	Cu*	Zn*
12-15-69	2BBC	120	116	68	.03	<.01	<.01	<.01
	3BBC	116	114	68	.01	<.01	<.01	<.01
	4BBC	132	127	80	.12	<.01	<.01	<.01
	5BBC	124	123	72	<.01	<.01	<.01	<.01
	6BBC	144	143	72	<.01	<.01	<.01	<.01
	7BBC	144	138	80	.05	<.01	<.01	<.01
	AVERAGE	130	126	73	.03	<.01	<.01	<.01
1-6-70	2BBC	-	-	-	-	-	-	-
	3BBC	-	-	-	-	-	-	-
	4BBC	-	-	-	-	-	-	-
	5BBC	136	132	76	.02	<.01	<.01	<.01
	6BBC	140	136	100	.01	<.01	<.01	<.01
	7BBC	-	-	-	-	-	-	-
	AVERAGE	138	134	88	.01	<.01	<.01	<.01
1-19-70	2BBC	106	107	56	<.01	<.01	<.01	<.01
	3BBC	124	117	68	.02	<.01	<.01	<.01
	4BBC	116	108	64	<.01	<.01	<.01	<.01
	5BBC	132	127	88	.02	<.01	<.01	<.01
	6BBC	148	146	76	.02	<.01	<.01	<.01
	7BBC	148	138	104	.02	<.01	<.01	<.01
	AVERAGE	129	123	76	.01	<.01	<.01	<.01
2-9-70	2BBC	108	103	82	.10	<.01	<.01	<.01
	3BBC	124	122	104	<.01	<.01	<.01	<.01
	4BBC	136	132	64	<.01	<.01	<.01	<.01
	5BBC	-	-	-	-	-	-	-
	6BBC	152	145	76	<.01	<.01	<.01	<.01
	7BBC	152	145	84	.08	<.01	<.01	<.01
	AVERAGE	134	129	82	.04	<.01	<.01	<.01
2-10-70	6BBC	148	146	68	.06	<.01	<.01	<.01
2-19-70	5BBC	140	132	64	<.01	<.01	<.01	<.01
2-25-70	2BBC	112	107	68	.05	<.01	<.01	<.01
	3BBC	132	127	104	<.01	<.01	<.01	<.01
	4BBC	124	116	64	.03	<.01	<.01	<.01
	5BBC	136	132	80	<.01	<.01	<.01	<.01
	6BBC	148	145	76	.02	<.01	<.01	<.01
	7BBC	140	136	100	.01	<.01	<.01	<.01
	AVERAGE	132	127	82	.02	<.01	<.01	<.01

Table 35

Chemical and Physical Analysis of Samples Collected in the Big Boulder Creek Drainage in 1969-1970 (ppm and units).

Date	Station	Test						
3-12-70	2BBC	116	114	60	<.01	<.01	<.01	<.01
	3BBC	132	127	92	<.01	<.01	<.01	<.01
	4BBC	-	-	-	-	-	-	-
	5BBC	148	145	80	.06	<.01	<.01	<.01
	6BBC	148	146	88	.02	<.01	<.01	<.01
	7BBC	144	138	84	.04	<.01	<.01	<.01
	AVERAGE	137	134	80	.02	<.01	<.01	<.01
3-27-70	2BBC	124	116	72	.05	<.01	<.01	<.01
	3BBC	132	126	68	.11	<.01	<.01	<.01
	4BBC	128	124	68	.03	<.01	<.01	<.01
	5BBC	124	122	60	.03	<.01	<.01	<.01
	6BBC	152	143	112	.02	<.01	<.01	<.01
	7BBC	148	138	76	.03	<.01	<.01	<.01
	AVERAGE	134	128	76	.04	<.01	<.01	<.01
4-7-70	2BBC	-	-	-	-	-	-	-
	3BBC	112	107	68	.11	<.01	<.01	.05
	4BBC	120	116	96	<.01	<.01	<.01	<.01
	5BBC	120	118	104	<.01	<.01	<.01	<.01
	6BBC	140	139	68	<.01	<.01	<.01	<.01
	7BBC	-	-	-	-	-	-	-
	AVERAGE	123	120	84	.03	<.01	<.01	.02
4-9-70	4BBC	108	104	52	<.01	<.01	<.01	<.01
	7BBC	144	138	72	.02	<.01	<.01	<.01
	AVERAGE	126	121	62	.01	<.01	<.01	<.01
5-1-70	2BBC	116	111	76	.02	<.01	<.01	<.01
	3BBC	116	113	64	.05	<.01	<.01	<.01
	4BBC	128	122	60	.01	<.01	<.01	<.01
	5BBC	112	107	80	<.01	<.01	<.01	<.01
	6BBC	136	127	80	.13	<.01	<.01	<.01
	7BBC	144	138	80	.05	<.01	<.01	<.01
	AVERAGE	125	119	73	.04	<.01	<.01	<.01
5-11-70	2BBC	100	96	56	.02	<.01	<.01	<.01
	3BBC	116	107	64	.03	<.01	<.01	<.01
	4BBC	96	85	68	<.01	<.01	<.01	<.01
	5BBC	124	122	76	.10	<.01	<.01	<.01
	6BBC	136	131	68	.01	<.01	<.01	<.01
	7BBC	144	138	92	<.01	<.01	<.01	<.01
	AVERAGE	119	113	70	.03	<.01	<.01	<.01

Table 36

Average Chemical and Physical Analysis by Station of Samples Collected from October 21, 1969, to May 11, 1970, in the Big Boulder Creek Drainage

Station	Test							
	TURB	TS	TDS	Hd	Fe*	Mo*	Cu*	Zn*
1BBC	<25	129	105	-	.02	<.01	<.01	-
2BBC	<25	111	106	67	.03	<.01	<.01	<.01
3BBC	<25	122	115	77	.04	<.01	<.01	.01
4BBC	<25	120	114	68	.02	<.01	<.01	<.01
5BBC	<25	128	123	77	.02	<.01	<.01	<.01
6BBC	-	144	140	80	.02	<.01	<.01	<.01
7BBC	-	145	138	85	.03	<.01	<.01	<.01
6ESC	<25	132	115	-	.01	<.01	<.01	<.01
Average	<25	128	119	75	.02	<.01	<.01	.01

*Dissolved

Table 37

Little Boulder Creek Station Locations

Station*	Location
1 LBC	Above confluence Castle Lake Drainage
2 LBC	Mouth of Boulder Chain Creek
3 LBC	Big Meadow
4 LBC	Proposed bridge crossing
5 LBC	Mouth
6 LBC	East Fork Salmon River
1F	Mouth of Frog Lake Creek
1C	In mouth Castle Lake Drainage

Data are also available from May 1970 to May 1971, and will appear in the final White Cloud, Boulder, Pioneer, aquatic environment - fishery report.

*Location documented on aerial photographs

Table 38

Chemical and Physical Analysis of Samples Collected in the Little Boulder Creek Drainage (ppm and units) in 1969

Date	Station	Test							
		Hd	Alk	TS	TDS	Cl	Al	Si	Na
7-9-69	1C	96	72	144	123	34	<.1	9	1
	1F	76	48	112	92	28	<.1	4	3
	3	52	40	104	84	32	<.1	4	2
7-10-69	4	40	36	104	87	40	<.1	4	3
	5	52	52	108	87	30	<.1	5	4
	6	116	92	160	142	30	<.1	3	7
7-24-69	1C	84	52	112	95	21	<.1	6	1
	1F	92	76	124	113	28	.1	8	6
	1F	92	76	168	142	28	.2	7	9
	2	56	40	92	77	21	<.1	3	2
	3	40	36	92	79	17	.1	4	2
	4	44	40	96	84	21	<.1	4	3
	5	60	40	100	86	23	<.1	4	4
	6	72	64	144	120	25	<.1	4	6
Average		69	54	118	100	27	<.1	4	3

Chemical and Physical Analysis of Samples Collected in the Little Boulder Creek Drainage (ppm and units) in 1969

Date	Station	Test								
		pH	O2	Turb	TS	TDS	Cu	Fe	Mo	Zn
5-28-69	2	7.0	10.0							
	3	7.0	10.0							
	4	7.3	9.0							
	5	7.0	9.0							
	6	8.0	9.0							
Average		7.2	9.4							
7-24-69	1C			<25	72	65	<.01	.03	<.01	
	2			<25	88	79	<.01	<.01	<.01	
	3			<25	92	79	<.01	<.01	<.01	
	4			<25	92	84	<.01	<.01	<.01	
Average				<25	86	76	<.01	.01	<.01	
8-8-69	1			<25	134	113	<.01	<.01	<.01	
	1C			<25	114	65	<.01	<.01	<.01	
	1F			<25	168	127	<.01	<.01	<.01	
	2			<25	160	87	<.01	<.01	<.01	
	3			<25	144	87	<.01	.05	<.01	
	4			<25	160	92	<.01	<.01	<.01	
	5			<25	168	95	<.01	.01	.01	
	6			<25	176	138	<.01	<.01	<.01	
	6			<25	136	127	<.01	<.01	<.01	
8-21-69	1			<25	120	110	<.01	<.01	.01	
	1C			<25	120	65	<.01	<.01	.01	
	1F			<25	196	123	<.01	<.01	.01	
	2			<25	102	95	<.01	<.01	.01	
	3			<25	118	90	<.01	<.01	.01	
	4			<25	168	92	<.01	.06	.01	
	5			<25	172	98	<.01	<.01	.01	
Average				<25	147	100	<.01	.01	<.01	
9-5-69	1			<25	124	117	<.01	<.01	<.01	
	1C			<25	90	65	<.01	<.01	<.01	
	1F			<25	152	133	<.01	.02	<.01	
	2			<25	164	98	<.01	<.01	<.01	
	3			<25	112	98	<.01	<.01	<.01	
	4			<25	140	102	<.01	<.01	<.01	
	5			<25	184	102	<.01	<.01	<.01	
	6			<25	162	145	<.01	.01	<.01	
9-25-69	1			<25	160	108	<.01	<.01	<.01	
	1C			<25	114	72	<.01	.01	.01	
	1F			<25	132	123	<.01	.12	<.01	
	2			<25	120	95	<.01	.10	<.01	
	3			<25	118	95	.01	.15	<.01	
	4			<25	122	98	.01	.06	<.01	
	5			<25	126	98	.01	.10	.01	
Average				<25	135	103	.01	.04	.01	
10-30-69	1			<25	118	107	.01	.01	-	.02
	1			<25	118	107	.01	.01	-	.02
Average				<25	118	107	<.01	<.01		.02
Total Average		7.2	9.4	<25	121	96	<.01	<.01	<.01	.02

Table 40

Chemical and Physical Analysis Averages for Stations in the Little Boulder Creek Drainage from May 28 to May 11, 1970

tion	Test													
	pH	O_2	Turb	TS	TDS	Fe*	Mo*	Cu*	Zn*	Hd	Alk	Cl	Al	Si
1	-	-	<25	129	110	.01	<.01	<.01	.02	-	-	-	-	-
1C	-	-	<25	109	78	.01	<.01	<.01	-	90	62	27	<.1	7
1F	-	-	<25	150	121	.04	<.01	<.01	-	86	66	28	.1	6
2	7.0	10.0	<25	122	88	.02	.01	<.01	-	56	40	21	<.1	3
3	7.0	10.0	<25	111	87	.04	<.01	<.01	-	46	38	24	.1	4
4	7.3	9.0	<25	126	91	.03	<.01	<.01	-	42	38	30	<.1	4
5	7.0	9.0	<25	129	105	.02	<.01	<.01	<.01	62	46	26	<.1	4
6	8.0	9.0	<25	150	137	.01	<.01	<.01	<.01	96	78	27	<.1	3
rage	7.2	9.4	<25	128	102	.02	<.01	<.01	.01	68	52	26	<.1	4

Table 41

Chemical and Physical Analysis of Samples Collected
in the
Little Boulder Creek Drainage
From January 6, 1970, to May 11, 1970 (ppm and units)

Date	Station	Test						
		TS	TDS	HD	Fe*	Mo*	Cu*	Zn*
1-6-70	5LBC	120	110	48	<.01	<.01	<.01	<.01
	6LBC	156	145	108	.03	<.01	<.01	<.01
Average		138	127	78	.02	<.01	<.01	<.01
1-17-70	5LBC	104	94	40	.02	<.01	<.01	<.01
1-19-70	5LBC	124	114	72	<.01	<.01	<.01	<.01
	6LBC	152	145	84	<.01	<.01	<.01	<.01
Average		138	129	78	<.01	<.01	<.01	<.01
2-9-70	5LBC	124	117	56	.02	<.01	<.01	<.01
	6LBC	152	145	100	<.01	<.01	<.01	<.01
Average		138	131	78	.01	<.01	<.01	<.01
2-25-70	5LBC	125	122	52	.03	<.01	<.01	<.01
	6LBC	152	145	112	<.01	<.01	<.01	<.01
Average		138	133	82	.02	<.01	<.01	<.01
3-12-70	5LBC	124	114	68	.04	<.01	<.01	<.01
	6LBC	140	132	100	.02	<.01	<.01	<.01
Average		132	123	84	.03	<.01	<.01	<.01
3-27-70	5LBC	120	110	64	.01	<.01	<.01	<.01
	6LBC	144	132	100	.02	<.01	<.01	<.01
Average		132	121	82	.01	<.01	<.01	<.01
4-7-70	5LBC	120	110	44	.04	<.01	<.01	<.01
	6LBC	156	145	80	.01	<.01	<.01	<.01
Average		138	127	62	.02	<.01	<.01	<.01
5-1-70	5LBC	124	117	88	<.01	<.01	<.01	<.01
	6LBC	144	138	84	.05	<.01	<.01	<.01
Average		134	127	86	.03	<.01	<.01	<.01
5-11-70	5LBC	128	117	100	.02	<.01	<.01	<.01
	6LBC	128	122	104	<.01	<.01	<.01	<.01
Average		128	119	102	.01	<.01	<.01	<.01

*Dissolved

Table 42

Slate Creek Station Locations

Station*	Location
1 CS	Mouth
2 CS	Below Sled Creek
3 CS	Below Sheephead Creek
4 CS	Below Hoodoo Creek
5 CS	Mouth Hoodoo Creek
6 CS	Above confluence Hoodoo Creek
1 CS (Carbonate Creek)	One mile above mouth Carbonate
1 CS (Silver Rule Creek)	Near mouth Silver Rule

Further data are available and will appear in the White Cloud, Boulder, Pioneer, aquatic environment - fishery report.

*Location documented on aerial photographs

Table 43

Analysis of Water Samples in the Slate Creek Drainage (ppm and units).

E ION	TEST Hd	Alk	TS	TDS	Cu	Fe	Ag	pH	Ca	Mg	Mn	Na	Cl	SO4	NO3	PO4	F	Pb	Zn	Turb	Mo
-68																					
					.03													<.01	.08		
					.02													<.01	.11		
					.04													.09	.21		
					.02													<.01	.01		
					.02													.32	.13		
					.03													.51	<.01		
5-68																					
	172				.06														<.001		
	158				.05														<.001		
	136				.05														<.001		
	92				.04														<.001		
	128				.07														<.001		
	80				.07														<.001		
69																					
	-	-	-	-	-	-													-	-	
	-	-	-	-	-	-													-	-	
	106	96	156	140	.03	.04													.01	< 25	
	82	104	124	113	.01	.10													.03	< 25	
	104	116	128	115	<.01	.22													.02	< 25	
	100	96	142	122	<.01	.06													.01	< 25	
69																					
	108	28		175		0		8.3	42	1	0	6	<2	30	.9	.09	.71				
	96	52				0		8.3	11	16	.34	<1	<2	29	.9	.02	.58				
	72	52				0		8.3	18	7	0	<1	<2	19	.9	0	.47				
	84	48				0		8.3	13	12	0	1	<2	13	.9	0	.06				
	76	56				0		8.3	21	6	0	1	<2	11	.9	0	<.01				
	76	32		125		0		8.3	24	4	0	2	<2	14	.9	0	.14				
69																					
	104	104	240	228	.01	.06	.03	8.0													
	112	120	236	220	.02	.04	.03	8.0													
	96	100	220	215	<.01	.04	.03	8.0													
	88	80	200	192	<.01	.02	.04	8.0													
	88	88	208	197	.01	.02	.02	8.0													
	76	72	172	159	.02	<.01	.01	8.0													
-69																					
			242	230	<.01	.02														<25	<.01
			272	250	<.01	.01														<25	<.01
			-	-	-	-														-	-
			256	215	<.01	<.01														<25	<.01
			176	145	<.01	<.01														<25	<.01
			154	138	<.01	<.01														<25	<.01
ages	101	77	195	175	.02	.04	.02	8.1	21	7	.34	2	<2	19	.9	.05	.32	.15	.387	<25	<.01

Table 44

Analysis of Water Samples Collected in the Slate Creek Study Area (ppm and units)

Silver Rule Creek

Date Station	Test									
	Turb	TS	Alk	Hd	Fe	Cu	Mo	Zn	TDS	Ag
5-8-69 CS-1	<25	142	112	108	.02	.03	-	.02	125	-
10-30-69 CS-1	<25	208	-	-	<.01	.01	-	<.01	145	-
2-14-69 CS-1	<25	-	-	140	<.01	.02	-	-	-	-
7-7-69 CS-1	-	210	96	92	.03	.01	-	-	202	.01
8-19-69 CS-1	<25	300	-	-	.02	<.01	<.01	-	203	-
Average	<25	215	104	113	.01	.01	<.01	.01	169	.01

Carbonate Creek

Date Station	Test									
	Turb	TS	Alk	Hd	Fe	Cu	Mo	Zn	TDS	Ag
5-8-69 CS-1	<25	88	92	64	.12	.07	-	.03	125	-
10-30-69 CS-1	<25	144	-	-	<.04	<.01	-	.01	113	-
2-14-69 CS-1	<25	-	-	140	-	<.02	-	<.01	-	-
7-7-69 CS-1	-	140	68	60	.08	.01	-	-	124	.01
8-19-69 CS-1	.25	132	-	-	<.02	<.01	<.01	-	127	-
Average	<25	126	80	88	.06	.01	<01	.01	122	.01

Photograph 8. Marshland drainage in Vat Creek Meadows to enhance sheep grazing--resulted in loss of wildlife and fisheries resources.

Photograph 9. Mine pollution problems in Big Boulder Creek, both aquatic and aerial. Here tailings are delivered annually to Big Boulder Creek from the Livingston Mill.

LIMITING FACTORS

Water Diversion

The factor causing the heaviest adverse impact on the fishery resource was the complete or partial diversion of stream waters for irrigation purposes. A number of irrigation diversion structures are in operation on both private and U. S. Forest Service lands during the summer months. Most of these diversions are not screened to prevent loss of young salmonoids into the fields. Some of the diversion dams present an impossible barrier to fish during the use portion of the year. Twenty-four known stream diversions within or near the area adversely affect about 50 miles of fluvial aquatic habitat. Approximately 29 miles of streams are either dewatered or suffer extreme low water conditions. Another 21 miles are adversely affected.

If the private acreage now under irrigation could be placed under public ownership as nonirrigable (natural lands) lands and Federal lands now presently irrigated reverted to natural conditions, this degradation could be prevented. Another alternative would be to use subterranean flows (pumping) to replace the diverted waters by going to sprinkling type irrigation. Estimates indicate that 3 acre-feet of water is being diverted to irrigate (2 months) 1 acre of land. Under sprinkler irrigation, 1 acre could efficiently be irrigated with less than 1 acre-feet of water or less than one-third of that presently used.

As shown by the hydrographs in Figures 11 and 12, the Salmon River waterflow, within portions of the area, is reduced about 50 percent at the peak of salmon spawning when water volume is a critical item. This water reduction occurs mainly during the latter part of July through the first part of October.

Records kept by the USGS from 1941 to 1953 at the Obsidian gauge* located near Obsidian, Idaho (Figure 5), indicate:

1. Only 2 years of 12 are the mean monthly low water discharges greater than 15 c.f.s. (Obsidian gauge located ½ mile below diversion). Anytime the mean monthly flow was below 20 c.f.s., the diversion was completely closed. This dewatered the stream area from the diversion (T. 7 N., R. 14 E., Sec. 3) to the Obsidian station and had adverse effects on the aquatic habitat on downstream to the crossing of Highway 93.

2. Ten years out of 11, the diversion caused minimum flows at the Obsidian gauge to fall below 10 c.f.s. Ten c.f.s. over a 20-foot channel, with an average velocity of 0.5 ft./sec. would only equal 0.2 feet of water depth. Low waterflows also result in increased water temperatures, lower oxygen concentrations, reduced food production, and increased predation and competition which results in lower survival and less growth. Low and dewatered conditions also result in loss of fishing area and amount of fishing pressure it can sustain.

3. Maximum peak discharge reaches 721 c.f.s., which shows there is an abundance of water for upstream storage that could be held and released during low flows (Table 1). This usually occurs during May. The hydrograph indicates that the mean annual maximum flows are about 270 c.f.s., and minimum flows of 18 c.f.s., after diversion, during August.

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*Obsidian gauge located in T. 7 N., R. 14 E., Sec. 3, on left bank 3/8 of a mile downstream from irrigation diversion dam and 1 mile upstream from Lost Creek.

Five diversions (three major) take waters from the Salmon River and Alturas Creeks for irrigation of pasture and hay lands. Two diversions, one on the Salmon River in T. 7 N., R. 14 E., Sec. 3 at lower streamflow stages diverts the complete river into the fields. Many salmon were left in the dewatered area and evidence showed that on certain years the majority of the adult salmon fell prey to unsportsman-type fishing due to low flows. The shallow, exposed waters of this type lead to a very unsportsman-type of fishing.

About 2 miles of this section (Salmon River) was taken out of production not only for rearing and spawning, but also as a quality fishery.

Another major diversion is on Alturas Creek in T. 7 N., R. 14 E., Sec. 4. This again dewatered the downstream area causing conditions as described previously. None of the diversions are screened to prevent fish from entering the canal systems and perishing in the field. The author observed young migrant salmon in a field in T. 7 N., R. 14 E., Sec. 6 that would perish at the end of irrigation. In 1969, no redds were found above this diversion.

A few salmon spawn above the Alturas Creek diversion entering the area before complete water diversion. In fact, a few chinook are caught by troll fishermen in Alturas Lake. Quite a number of salmon gain entrance to the stream above the complete diversion in Section 3 before the migration block is installed and spawn above.

Waters for irrigation are diverted into the fields and waste waters are diverted back into the river on many occasions. This could reduce water quality by increasing to an unknown degree sediment loads and offsite water temperatures.

The irrigation demand hits its peak just when the stream regimen hits its low, thus when the water is in greatest demand for the fishery resource, it is diverted for irrigation (Figure 1).

Other divers ns on the Upper Salmon River occur in T. 7 N., R. 14 E., Sec. 10 (two diversions), and a large diversion is located in T. 8 N., R. 14 E., Sec. 8, just below the Hell Roaring Creek Bridge. These diversions about eliminate what could develop into an all-summer float or canoe fishery or just float recreation.

Many of the small tributaries are also completely diverted and dewatered for irrigation, such as Champion Creek. These diversions or lands should also be considered in assessing future values on land priority status.

Minimum flows* below diversions will need to be established as outlined in Table 2. All water diversions occurring downstream from salmon and steelhead spawning areas should be screened to eliminate the loss of downstream moving salmonoids. Also, all major diversions should have adequate fish passage facilities in accordance with Idaho State Law.

As shown by the hydrograph** in Figures 4 and 5, the Salmon River waterflow within portions of the area is reduced about 50 percent at the peak of salmon spawning, when water volume is a critical item. This water reduction occurs mainly during the last part of July through the first part of October.

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*Minimum flows are only estimates at this time. Actual flows needed will take further study. Estimated minimum flows, however, should be close to actual to actual flows needed.

**Blaine Molyneaux, Watershed Specialist, Sawtooth N.F., provided hydrograph data.

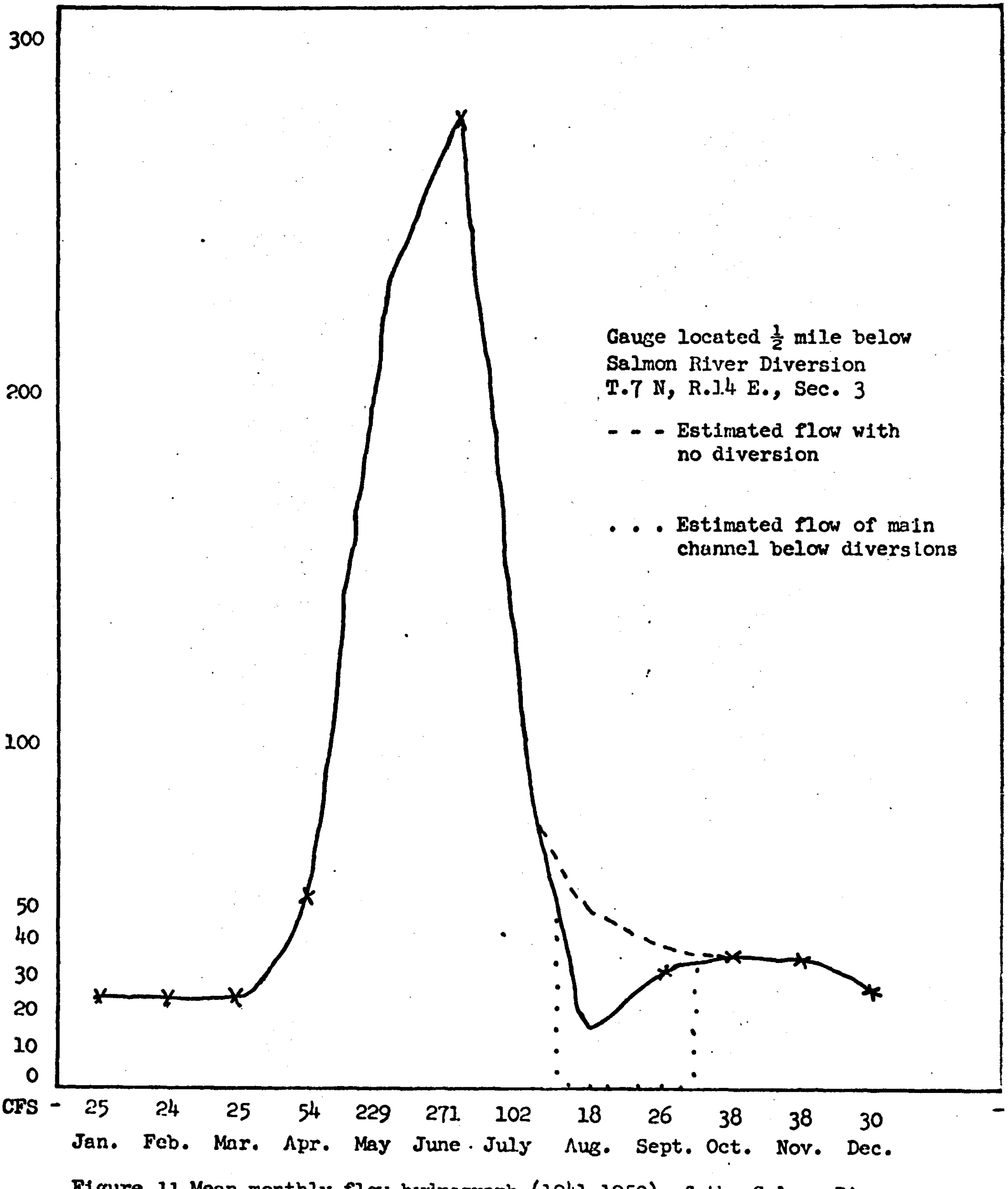

Figure 11 Mean monthly flow hydrograph (1941-1950) of the Salmon River near Obsidian, Idaho, showing loss of water during low flows.

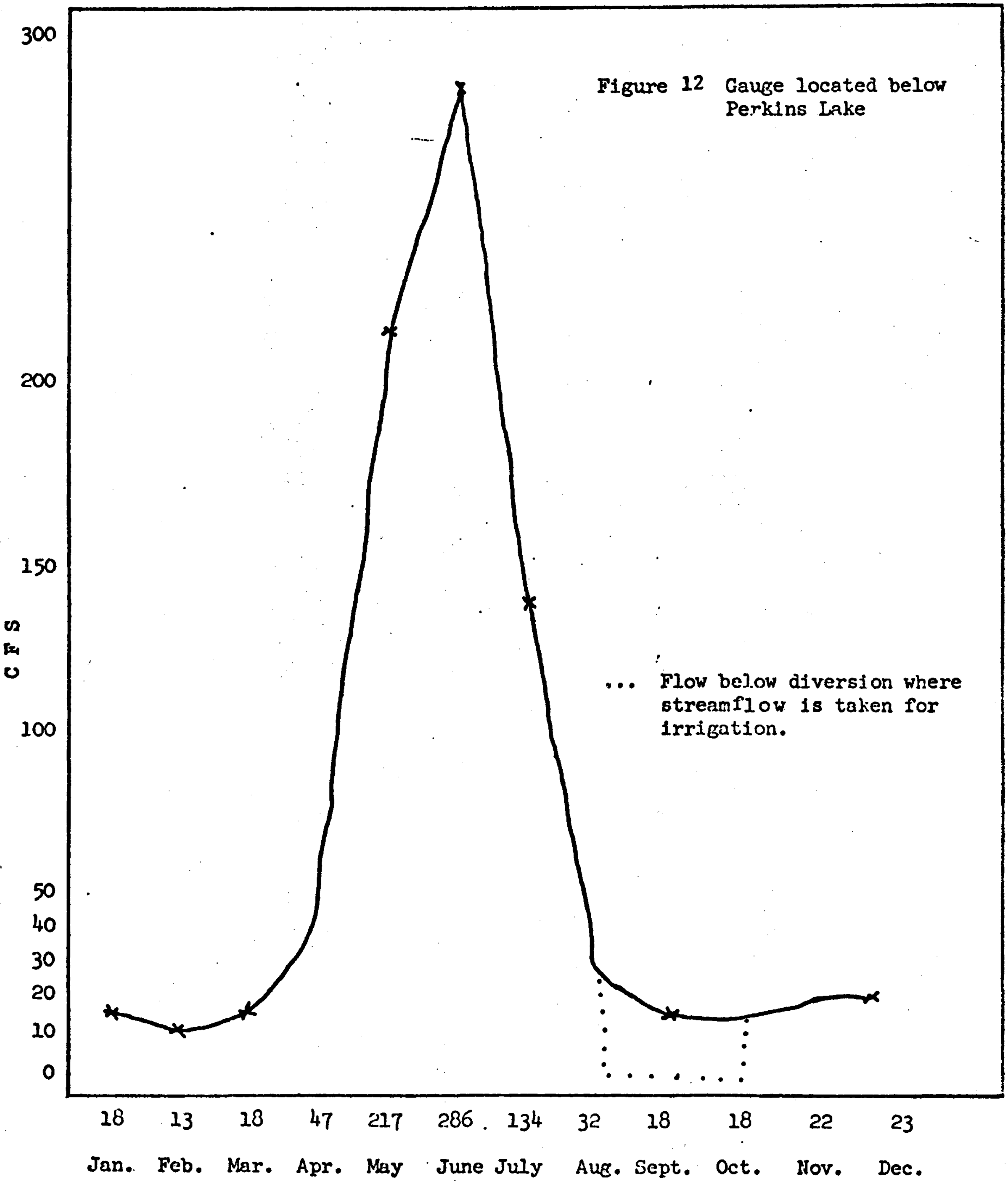
Figure 12 Gauge located below Perkins Lake
300
200
150
100
50
40
30
20
10
0
C F S
... Flow below diversion where streamflow is taken for irrigation.
18 13 18 47 217 286 134 32 18 18 22 23
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Table 45 Yearly water discharge, in cubic feet per second, at the Obsidian water gauge.

	DISCHARGE *			
Year	Maximum	Minimum	Mean	Acre-Feet
1941	421	---	---	---
1942	475	2	64	46,320
1943	664	6	128	92,410
1944	348	8	66	48,400
1945	348	9	54	39,680
1946	477	8	76	55,040
1947	523	6	70	50,990
1948	706	6	74	54,170
1949	416	4	65	47,130
1950	532	6	78	56,580

* Water year ending September 30

Drainage Area 94.7 sq. miles

Average Annual Discharge 81.1 cfs, 58,170 acre feet

Diversions above station for irrigation of about 1700 acres (1948)

Table 46 Location of stream diversions and minimum flows needed for fishery resource enhancement.

Stream	Location	Minimum Flow Needed	Est. Normal Min. Flows
Salmon River	T.7 N., R.14 E., Sec. 3	35	53
Salmon River (2)	T.7 N., R.14 E., Sec. 10 & 3	25	45
Salmon River (3)	T.8 N., R.14 E., Sec. 8, 5 & 32	60	150
Alturas Creek	T.7 N., R.14 E., Sec. 4	20	20
Champion Creek	T.8 N., R.14 E., Sec. 14	10	10
Fourth July Creek (3)	T.8 N., R.14 E., Sec. 10 & 12	10	10
Fisher Creek	T.8 N., R.14 E., Sec. 4	8	8
Pole Creek (2)	T.7 N., R.14 E., Sec. 23 & 25	8	--
Salmon River	T.7 N., R.14 E., Sec. 26	25	--
Taylor Creek	T.7 N., R.14 E., Sec. 11	5	--
Salmon River	T.8 N., R.14 E., Sec. 28	60	--
Williams Creek	T.9 N., R.14 E., Sec. 20	--	--
Gold Creek (3)	T.9 N., R.14 E., Sec. 17 (2) & 8	--	--
Cleveland Creek (2)	T.10 N., R.14 E., Sec. 31	--	--
Boundary Creek	T.10 N., R.14 E., Sec. 31	--	--

-- Not known at this time

In the future, stream diversion facilities that remain a necessity for other multiple uses, such as irrigation of pasturelands should be converted to permanent structures. All present temporary structures should be eliminated. N-v structures should be designed for controlled flows or both diverted and undiverted streamflow waters. The structures should be designed for fish passage when needed. This will be expanded on in a later section in this report.

Wetlands Drainage

The Vat Creek Meadow is located within the proposed SNRA in the Upper Salmon River drainage near Alturas Lake. The purpose for draining part of this meadow area was for increased sheep grazing use (Photograph 8). By draining the area, it allowed the meadow to become dryer, thus allowing sheep to enter and graze the area. Prior to draining, the meadow was too wet and sheep would not penetrate onto it.

This meadow lies in a very attractive area in which recreation use has erupted within the past 20 years and will continue to increase in use.

The Vat Creek Meadows support a brook trout fishery. However, it probably has minor use at the present time. It will have more demand as the increased recreation pressure is exerted. It does have the possibility of supplying a small size brook trout fishery to that portion of the recreation population that may now, or at some later date, desire this type of fishing.

Construction practices that lower water levels and drain streams, marsh or pond areas, are detrimental to the fishery.

Fishing Access

Much of the stream area within the depositional lands runs through private lands. To date, most of these lands are open to public access, but public access has not been assured for the future. If the aquatic resources are to be utilized fully, they must be readily available to the recreationist. The value of these lands as related to the fishery for access has been discussed in reports listed in the bibliography.

High Mountain Lake Water Levels

Many lakes within the area were found to be unsuitable for supporting a fishery. The White Cloud Lake inventory pinpointed these lakes and suggested routes to be taken to place these lakes in production. A few lakes could be used as demonstration projects to determine the possibility of placing these lakes in fishery production.

FISHERY NEEDS AND ENHANCEMENT

Lacustrine Environments

The need for additional water area may continue to increase as more and more demand i- placed on the existing water resources. There are artificial lake sites within the SNRA (See "Recommendation for Future Fishery Resource Management Within or Near the Proposed Sawtooth National Recreation Area," 1968) that could be placed into highly desirable recreation use. One site, very feasible, is located in the Upper Salmon River. These artificial lakes could be constructed to resemble natural lakes and match the esthetic values of the area. The dams could be built to match the terminal moraines so common to the area. Not only would these artificial lakes provide a controllable fishery, but also other types of water recreation such as boating, swimming, and water skiing. Proposed impoundment site location, size, cost, etc., are found in Table 47.

These proposed artificial lakes would allow complete control of game fish populations as water levels, water volume, and water releases could be controlled. It is very possible, however, that these artificial lakes would not fit into the esthetic needs of SNRA. They definitely would not fit into the concept of keeping conditions as close to the natural environment as possible.

The proposed SNRA contains about 300 high mountain lakes, with many of them void of fish populations. Very little is known about this aquatic habitat in the Sawtooth Primitive Area portion as no work has been done to inventory or study this habitat.

Table 47 Preliminary estimates of cost and size of proposed water storage impoundments within and adjacent to the proposed Sawtooth NRA (estimates in rough form only).

Area	Acre Feet		Cost
Artificial Lake Storage			
Upper Salmon River	20,000		$ 140,000.00
Pole Creek	9,000		140,000.00
Fish Hook Creek	15,000		4,176,000.00
Iron Creek	25,000		850,000.00
Hell Roaring Creek	15,000		1,717,000.00
		Total	$7,023,000.00

Table 48 Location and estimated costs of water storage, transmission, and diversion projects to enhance fisheries in the proposed Sawtooth NRA.

15 small stream diversions @ $4,200		$ 63.000
5 medium stream diversions @ $10,350		51,750
4 large diversions @ $28,000		112,000
Upper Salmon River Dam		140,000
Pole Creek Dam		140,000
Hell Roaring Dam		1,717,000
Fishhook Creek Dam		4,176,000
	Total	$ 6,399,750

Many of these lakes are not producing a fishery resource at the present time because of limiting factors. It will take a habitat inventory to pinpoint deficiencies. Some lakes do not produce because they lack sufficient depth. In some cases, if the effects do not cause detrimental conditions to other resources, the water levels in these lakes can be raised placing them back into production. Other lakes have adequate conditions most of the year, but lose their water during the dry season. Some of these lakes could be placed into production by sealing the bottom or grouting the outlets.

Because of predominant granitic environment, lakes within the area tend to be low in fertility, thus food chain production is low resulting in small standing crops of fish. Lakes, however, are capable of building their own fertility. The future may demand artificial control of food chain production in order to increase its potential for serving the recreationist. Chains of lakes could be increased for food production by fertilizing only the top lake. This should be experimented with. A chain in the "White Clouds" offers an ideal situation for determining benefits to be derived. It is very possible that types of organisms now lacking in food chains such as shrimp and salamanders should be stocked in lakes (now devoid) that offer the right habitat. This type of management work would be done in cooperation with the Idaho Department of Fish and Game and Public Health.

<u>Fluvial Environments</u>

Streams, like lakes, also have their limiting factors which need to be determined and decided if it is feasible and necessary to correct them for

enhancement purposes. Only if the aquatic environment is in top condition will it offer the media to produce the quality and quantity of the fishery to meet the demands of the recreationist. Past years have proven that the movement towards understanding and managing the aquatic environment has not progressed sufficiently to meet the demands.

Streams within the area provide the requirements for both the resident and anadromous fishery. Continuation of the anadromous fishery depends on both downriver and upriver management. The main item to consider in management of the stream fishery resource is to return them to their natural condition. Care must also be taken so that increasing uses in the area do not further damage the aquatic habitat. A documentary aquatic habitat study on the major streams would allow any future changes (degradation) in habitat conditions to be detected and keyed to causes. Possible sources of sedimentation, detrimental water additives, increased water temperatures, abnormal water conditions (both high and low flows), etc., could be constantly monitored. All anadromous spawning areas need to be documented for present conditions and watched carefully in the future so that optimum conditions can be attained and kept. It is not known by the author what existing spawning conditions are, but other than lack of water, the author assumes they are in fair to good condition. The environments which summer chinook utilize on the lower portion of the Salmon River and East Fork Salmon River within the SNRA and Valley Creek need careful management, as this race is constantly declining and could become a rare race or even an endangered race. Because of this importance, special emphasis should be placed on needs as they pertain to aquatic environment conditions.

Feasibly and economically there is not very much that can be done physically to enhance the fluvial aquatic habitat beyond return to their original status prior to land uses. The big challenge will be to return them to near-natural condition. Under present practices of stream diversion, most streams during low flows on the east side never reach their confluence with the main Salmon River. Fourth of July, Champion, and other valuable streams are completely dewatered by the diversion practices. This is not only damaging to their fishery, but to migrating fisheries within the Salmon River. This has been very detrimental to Dolly Varden runs to upstream spawning areas.

Grazing practices resulting in streambank stresses could possibly get some relief by certain rest-rotation systems or other alternatives that will relieve stress. This type of stream damage is very serious and deserves added attention.

It is possible that certain stream areas can be improved with use of stream enhancement structures such as gabions, weirs, K-dams, shade or cover producers, anchor logs, boulder retards, deflectors, velocity blocks, etc. It would take special studies to determine if this would be of any benefit to the fishery.

Like some of the lakes, many miles of streams contain nongame fish. Sections of some streams may need to be reclaimed, if feasible, through eradication of existing populations and the stream reverted to salmonoids, which are the species in demand by the recreationist. Undesirable species would then be blocked from re-entering these areas.

Vat Creek marsh, an artificially drained area, has been critically altered from its native fisheries-wildlife environment to a degraded condition. This was done by the Forest Service to allow sheep grazing on the altered marsh. If this were returned to natural conditions, it would greatly benefit the fisheries-wildlife values. This could be easily done with very little cost.

Under present management, where gates are continually left open, there is very little chance for a fishery to exist. If the gates were completely closed and the meadow again allowed to become a wetland, it could have more potential for fisheries and waterfowl than originally. This is because it would have more water surface area, depth, and volume than in its original condition. If converted in this manner, fishing use would increase over present use.

Fish Passage

Under present management, conditions both upstream and downstream moving salmon, steelhead, and trout are faced with movement or migration blocks at certain locations on the Main Salmon River and its tributaries. At all diversions, if there were adequate minimum flows through good fish passage facilities with unrestricted passage of salmonoids, it would greatly benefit the resource. Adequate minimum flows will need to be assured to protect and maintain fishery values.

Some lakes could benefit from additional inlet stream area access for fish spawning and rearing. It may be of value in lakes such as Pettit, Redfish, and Yellow Belly.

Table 49 Preliminary cost estimates to build proper stream diversion structures with minimum flow controls within proposed Sawtooth NRA (estimates in rough form only).

Small Diversions (15)	@ $ 4,200	$ 63,000
Medium Diversions (5)	@ 10,350	51,750
Large Diversions (4)	@ 28,000	112,000

Land Status

Public access to the entire Salmon River and tributaries within the SNRA is needed if full recreation potential is needed. Access is available on the public lands, but the large segments of private lands along the Salmon River and tributaries could present access blocks. The majority of the lands in the valley floor are in private ownership--the river is bordered by 16 miles of private land from Smiley Creek to Redfish Lake Creek. Because certain sections of streams and their surrounding land areas are under private ownership, it presents the possibility that certain segments of the recreation resource may become unavailable to the recreationist.

To prevent this possibility, lands bordering water recreation areas could either be brought into public ownership or permanent access acquired.

Certain areas (both land and water) valuable for anadromous fish spawning and rearing may need be withdrawn from certain possible detrimental uses. Federal lands (532 acres) have already been applied for withdrawal from certain uses, but about 30,000 more acres are needed. In 1955, the United States Fish and Wildlife Service published in the Federal Register the intent to withdraw approximately 31,000 acres of Upper Salmon River area from entry under mining laws. The withdrawal of these lands may be necessary to ensure adequate protection of the anadromous fish spawning areas.

Reclamation and powersite withdrawals within the study area cover approximately 30,000 acres and 24,000 acres respectively. Dam construction and land flooding in certain areas would pose serious fishery and other resource management problems. However, according to latest reports, there is no current interest in these sites and little possibility of reclamation or power projects in the foreseeable future.

Table 50 Lakes and streams in or near the proposed Sawtooth NRA that could need species composition control.

Lake	Surface Acres - Miles	Estimated Cost	Nongame Fish Species
(NF) Alturas Lake	848	45,000	Sq, Su, Rs
(NF) Alturas Creek	5	1,000	Sq, Su, Rs
*Hell Roaring Lake	58	4,500	Sq, Su
*Hell Roaring Creek	5	500	Sq, Su
(NF) Little Redfish Lake	76	6,000	Sq, Su, Rs
(NF) Perkins Lake	46	4,000	Sq, Su, Rs
Pettit Lake	404	31,500	None at present time
Pettit Lake Creek	4	500	Sq, Su, Rs
(NF) Redfish Lake	1,550	NF	Sq, Su, Rs
(NF) Redfish Lake Creek	3	NF	Sq, Su, Rs
(NF) Salmon River	14	3,000	Sq, Su, Rs
Sawtooth Lake	200	22,500	Br
Stanley Lake	320	20,000	Rs
Yellow Belly Lake	170	14,500	Su, Rs
Yellow Belly Lake Creek	4	400	Su, Rs

*Eradicated in 1971.
NF - Not feasible with present methods except possible squawfish control.
Rs - Redside shiner.
Br - Brook trout.
Sq - Squawfish.
Su - Sucker.

Fish Species Composition

As mentioned before, portions of the available water area are not in top game fish production. Some of the habitat may need to be in total game fish production.

During the 1920's and 1930's, both native and exotic fishes were heavily stocked throughout the lake and stream systems. The redside shiner was purposely stocked in many of the lake systems (resulted also in stream stocking), which was very unwise management as now demonstrated by Stanley Lake and others. This species of fish, once introduced, become effective competitors with trout. The large numbers of stocked smelt, landlock salmon, Sunapee golden trout, etc., passed out of the picture.

Brook trout were also stocked indiscriminately in many areas. They produced fair fisheries in some waters, but some lakes and streams suffered because of the brook trout tendency to become overpopulated and stunted. Sawtooth and the Bench Lakes are examples where brook trout have, in the past, become stunted. These lakes and others may someday need to be eradicated of their brook trout populations and replaced with populations of cutthroat or rainbow trout. The author has visited Sawtooth Lake when it was a producer of fairly large cutthroat trout (1946). At this same time, it was also still producing smelt.

Hell Roaring Lake is another example of a fairly productive water that contained an imbalanced fish population. During September of 1971, the Fish and Game Department chemically treated this lake of an existing rough fish population and will convert it into a game fishery. The lake was

dominated by the fine-scaled sucker, squawfish, dace, redside shiner, and stunted kokanee. Because of this, Hell Roaring Lake was not providing the resource and resulting recreation use it should be.

The proposed SNRA area offers an excellent opportunity to increase the use and value of the aquatic environment. It also offers the challenge to increase the range of endangered or rare species. The Idaho Fish and Game Department has already taken steps in this direction. During future aquatic environment studies, lakes need to be identified that fit the needs for increasing the range of desirable species. The California golden trout has been eliminated in some areas by stocking with other species, or they have died out because of other factors. Lakes need to be evaluated carefully to see what species would have the greater value. The preservation or enhancement of native fluvial cutthroat trout needs constant consideration.

Fish Stocking

Fish stocking is a function of the Idaho Fish and Game Department. Steadily increasing fishing pressure is going to necessitate the stocking of more waters within the area with larger numbers of catchable and fingerling trout. Presently, 32,000 catcable size rainbow trout are being stocked annually in Redfish Lake. In addition, most of the accessible lakes and waters are stocked annually by the Idaho Fish and Game Department. The Idaho Fish and Game Department needs access to certain water areas for motorized vehicles so fish stocking can be done efficiently and offer the best return to the creel.

Stocking of species not already found or previously stocked within the area should be scrutinized very closely.

There are small springs in the Sawtooth Valley area that lend themselves to use as rearing ponds for anadromous fish. One rearing pond is presently being utilized by the Idaho Fish and Game Department in the proposed SNRA at Decker Flat with use of Salmon River waters. Spring waters, which have proven to be successful, could be needed by the Department as this program is expanded. One of the most promising tools available today to increase salmon and steelhead spawning runs is the use of rearing areas. Also, there may be areas within the SNRA which could be stocked with hatchery reared smolt size salmon and/or steelhead. Return adult runs would be trapped at the release site to perpetuate these artificial runs.

CONCLUSIONS

1. The Upper Salmon River and its tributaries are in near-natural conditions, except for the presence of diversions from about July 30 through the middle of September.

2. The water diversion to the pasturelands occurs at a time when this same water is needed for the fishery and other recreation resources.

3. Salmon, steelhead, and other game fish (undetermined numbers) are being diverted to perish in the fields.

4. Since the irrigation season overlaps the times when anadromous fish are migrating, present total stream diversions are movement blocks to anadromous fish.

5. Adequate minimum waterflows would protect and enhance fisheries values.

6. The high mountain lakes offer a chance to increase the production of game fish populations and, in turn, increase their recreational value.

7. Past indiscriminate stocking of some fish species has been detrimental to the already established fisheries.

8. There is great potential for increasing the value of the fishery resource and the amount of fishing pressure the area can provide.

9. The main factors decreasing the productivity of the aquatic environment and, in turn, the fishery resource are livestock streambank damage,

water diversions, road construction, low water conditions, fish passage blocks, dewatered stream areas, trash or rough fish populations, winter icing conditions, and low food chain production.

10. The fishery resource within the proposed Sawtooth NRA should be given high priority as a managed recreation resource.

11. Private lands present the possibility that access by the recreationist to important segments of the recreation resource may be obstructed.

12. Some of the lakes and streams contain nongame fish populations; therefore, the aquatic habitat is not producing to its fullest use as a recreation resource.

13. To meet the future anticipated demand on the fishery resource, it is possible that new water areas (artificial lakes) may need to be formed and original lakes and streams brought into more productive management.

14. The Vat Creek wetlands drainage project has been very detrimental to the fisheries, waterfowl, shorebirds, muskrat, and other wetlands wildlife.

15. Subterranean water sources may be needed to augment waterflows for irrigation and relieve degrading conditions on the fishery.

16. The need will increase for enhancing fishery values and expanding opportunities for sport fishing.

17. The annual migration of salmon and steelhead trout from the Pacific Ocean to the upper reaches of the Salmon River is an outstanding biological feature of the area, and an extremely interesting bit of natural history for visitors to view and enjoy.

18. The continuation of the anadromous fisheries is dependent on the preservation of the spawning and rearing areas, many of which lie within the Sawtooth NRA.

19. Improvement or maintenance of habitat for all forms of wildlife and fish will be increasingly essential.

20. Rare and endangered species may require special attention in areas of suitable habitat.

BIBLIOGRAPHY AND LITERATURE CITED

Anonymous. Mountain Lakes of Idaho. Idaho Fish and Game Department. 56 pp. 1967.

Anonymous. A National Recreation Area in Sawtooth Country (A Concept). U. S. Forest Service, Region 4. 17 pp. 1969.

Anonymous. Sawtooth Mountain Area Study, Idaho Summary. U. S. Forest Service and National Park Service. 43 pp. 1965.

Anonymous. Status Report. Columbia River Fish Runs and Commercial Fisheries, 1938-70, Joint Investigation Report. Fish Commission of Oregon and Washington Department of Fisheries. Volume 1, No. 1. 1971.

Gordon, Douglas. An Economic Analysis of Idaho Sport Fisheries. Statewide Fishing Harvest Survey. F-18-R-15, Job No. 2. Idaho Fish and Game Department. 6 pp. 1970.

Irizarry, Richard. The Effects of Stream Alteration in Idaho. Idaho Fish and Game Department. Project F-55-R-2. 1969.

Irving, Robert. "Winter Fishery at Jimmy Smith Lake." Idaho Fish and Game Department. Idaho Wildlife Review. 2 pp. 1955.

Klotz, A. W. Chemical Analyses of a Group of Lakes and Streams in Southern Idaho and Their Relationship to Fish Production. University of Idaho School of Forestry. Bulletin No. 8. 1938.

Mallet, Jerry. et al. Idaho Salmon and Steelhead - Status Report for 1969. Idaho Fish and Game Department. 1970.

Platts, W. S. Aquatic Habitat Procedure for Inclusion in the Soil-Hydrologic Aquatic Habitat Survey for the Idaho Batholith. U. S. Forest Service, Region 4. 7 pp. 1968.

Platts, W. S. Aquatic Habitat Studies in the White Cloud Mining Influence Area (Little Boulder Creek Proposed Road Location), Challis National Forest, Progress Report II. U. S. Forest Service, Region 4. 5 pp. 1968.

Platts, W. S. Aquatic Habitat Studies in the White Cloud Mining Influence Area (Willow Lake and Little Boulder Creek Pollution), Challis National Forest, Progress Report I. U. S. Forest Service, Region 4. 5 pp. 1968.

Platts, W. S. Aquatic Environment Studies in the Wild and Scenic Rivers Study Area - Salmon River Studies, Progress Report I. U. S. Forest Service Region 4. 1971.

Platts, W. S. Changes in Aquatic Habitat Conditions Within the Vat Creek Wetlands Drainage Project. U. S. Forest Service, Region 4. 6 pp. 1969.

Platts, W. S. Documentation of Aquatic Habitat Conditions in the Upper Salmon River in the Proposed Sawtooth National Recreation Area, Progress Report I. U. S. Forest Service, Region 4. 1970.

Platts, W. S. Fishery Management Within the Idaho Batholith. U. S. Forest Service, Region 4. 3 pp. 1968.

Platts, W. S. Preliminary Report on Changes in the Fishery Resource Which Could Result from the Proposed Upper Big Wood River Supplemental Storage Project. U. S. Forest Service, Region 4. 16 pp. 1968.

Platts, W. S. Proposal for Eradication of Existing Rough Fish Species from Hell Roaring Lake, Sawtooth National Forest. U. S. Forest Service, Region 4. 4 pp. April 1968.

Platts, W. S. Recommendations for Future Fishery Resource Management Within or Near the Proposed Sawtooth National Recreation Area. U. S. Forest Service, Region 4. 26 pp. 1968.

Platts, W. S. Recommendations on Land Status Effects on the Fishery Resource in the Upper Salmon River on or Near the Sawtooth Mountain Study Area. U. S. Forest Service, Region 4. 20 pp. 1968.

Platts, W. S. Salmon and Steelhead Fish Passage and Escapement in the Columbia and Snake River Drainages. U. S. Forest Service, Region 4. 8 pp. 1967.

Platts, W. S. White Cloud Aquatic Habitat Studies (Outline). U. S. Forest Service, Region 4. 9 pp. 1970.

Platts, W. S. The White Cloud-Boulder-Pioneer Aquatic Environment and Fisheries Study - Interim Report. U. S. Forest Service, Region 4. 276 pp. 1970.

Richards, J. A. An Economic Evauation of Columbia River Anadromous Fish Programs. Ph.D., Thesis. Oregon State University. 275 pp. 1968.

Rodeheffer, I. A. A Survey of the Waters of the Sawtooth National Forest, Idaho. Department of Commerce, Bureau of Fisheries. 39 pp.

Welsh, Gebhards, Metsker, Corning. Inventory of Idaho Stream Containing Anadromous Fish, Including Recommendations for Improving Production of Salmon and Steelhead, Part I. Idaho Fish and Game Department. 1965.

APPENDIX I - METHODS, TECHNIQUES, AND EQUIPMENT

Fluvial Aquatic Environment

The methods and techniques for the physical fluvial habitat condition inventory follow, with modifications, those outlined by Herrington (1967) in Research Paper INT-41. Herrington found that results from the techniques and methods when tested on three streams provided acceptably precise estimates of stream width, stream surface area, pool area, riffle area, stream depth, and streambed composition, as well as estimates of the stability and vegetative cover of the streambanks. Modifications of the methods and techniques used by Herrington were used to better evaluate such things as production areas, streambed composition, streambanks, pool quality, sedimentation influence, and instantaneous, spatial, and temporal changes in and between streambed areas. The sampling system has been intensified over that used by Herrington in certain areas to gain increased reliability. The inventories and studies were set up in an attempt to get away from ocular quality descriptions which tend to give erroneous conclusions to quantity descriptions of statistical significance.

The studies had three main objectives:

1. To determine the instantaneous aquatic environment conditions.

2. To determine any temporal conditions that may take place in the aquatic environment due to the different land uses of changing natural conditions.

3. To determine what areas of the aquatic environment need enhancement so they will contribute a more valuable or larger fishery resource.

Stations

Each station, for stream inventory purposes, was established randomly and pinpricked on aerial photographs so future studies or monitoring to determine temporal changes can be conducted using the area for transect locations. The station, once established and marked on the aerial photograph, was then found on the ground with the use of the photograph. To avoid any bias resulting from locating the stations with the use of aerial photographs, the first station transect was located 100 feet upstream from the actual station location.

At each station, five stream transects were evaluated. The five stream transects within each station were located 50 feet apart. Transects were run from bank to bank at a 90 degree angle to the centerline of the stream. The following measurements and condition factors were taken:

1. Water surface and pool and riffle width to nearest foot.
2. Average stream depth to nearest inch (three measurements averaged).
3. Pool rating and feature.
4. Aquatic vegetation.
5. Streambed surface materials.
6. Streambed depth materials in certain study areas only.
7. Streambank cover, condition, and type streambed surface material composition.

The streambed surface material composition was determined by direct measurement of the bed surface. The streambed transect was broken down to 1-foot intervals, the dominant surface material determined the 1-foot breakdown.

For example, if within the 1-foot interval there were 8-inch sediment and 2-inch gravel and 2-inch rubble, the 1-foot measurement would be completely classified as sediment. On each transect, the streambed surface material was measured and classified according to the following guidelines:

1. Boulder -----------------304.8 mm or over in diameter
2. Rubble ------------------76 to 304 mm in diameter
3. Gravel ------------------4.7 to 76 mm in diameter
4. Sediment ----------------Less than 4.7 mm in diameter
5. Other materials -------- Logs, debris, etc.

Pool-Riffle

Stream area was stratified as to pool and riffle. The pools in turn were classified as to suitability to fish habitat based on the criteria outlined in Table 27. Riffle and pool area were measured to the nearest foot and the two equaled the stream width.

Streambank Conditions

Bank condition at both ends of each transect was rated as excellent (2.0), good (1.5), fair (1.0), and poor (0.5). Streambank type was determined in the same manner using the materials at the point of transect intersection with the bank as the material evaluated. This allowed a quantity estimate of the different types of materials or conditions affecting the streambank environment. Streambank cover was rated as forested (2.0), brush (1.5), grass (1.0), and exposed (0.5).

Table 51

Pool			
Quality Class No.	Length or Width	Depth	Shelter[1]
1	Greater than a.c.w.[2]	2' or deeper	Abundant[3]
	Greater than a.c.w.	3' or deeper	Exposed[4]
2	Greater than a.c.w.	2' or deeper	Exposed
	Greater than a.c.w.	$<2'$	Intermediate[5]
	Greater than a.c.w.	$<2'$	Abundant
3	Equal to a.c.w.	$<2'$	Intermediate
	Equal to a.c.w.	$<2'$	Abundant
4	Equal to a.c.w.	Shallow[6]	Exposed
	Less than a.c.w.	Shallow	Abundant
	Less than a.c.w.	Shallow	Intermediate
	Less than a.c.w.	$<2'$	Intermediate
	Less than a.c.w.	2' or deeper	Abundant
5	Less than a.c.w.	Shallow	Exposed

1. Logs, stumps, boulders, and vegetation in or overhanging pool or overhanging banks.
2. Average channel width.
3. More than 1/2 perimeter of pool has cover
4. Less than 1/4 of pool perimeter has cover.
5. 1/4 to 1/2 perimeter of pool has cover.
6. Approximately equal to average stream depth.

Streambed Depth Composition

Three stream areas below potential new land uses were sampled for depth materials because they lend themselves to key indicator areas should any land uses cause any changes in the aquatic environment. The streambed depth composition was determined by sampling the bed to a depth of 6 inches with the use of a streambed depth core sampler. Twenty core samples were taken randomly in each area.

The core sample material was separated into 16 size classes with fines collected for further hydrometer analysis. The actual volume of materials is expressed as percent of total so all samples could be compared. The samples were analyzed by the U. S. Forest Service Materials Laboratory, Division of Engineering, Salt Lake City, Utah.

Chemical analysis for water suitability in both the fluvial and lacustrine environments was conducted as outlined under "Standard Methods." Most of the analysis was done by the Idaho State Health Department. Some tests, such as pH, oxygen, hardness, alkalinity, free carbon dioxide were done in the field.

Water temperatures in Alturas and the Main Salmon River were measured twice a week for 7 weeks (during the study period) with maximum and minimum thermometers. Streamflow was measured, with a Price current meter, twice during the course of the 7-week period. Hydrochemistry analysis was done by the Idaho State Department of Health with water samples collected once a week.

Lacustrine Aquatic Environment

To determine the potential aquatic environment and resulting fishery resource in the lacustrine environment, over 100 lakes and ponds were inventoried and studied in the White Cloud Area - 26 in the Boulder area and 19 in the Pioneer area.

The items studied and measured were those considered most important in determining the physical and chemical inputs resulting in fish survival production, fishery quality, and fishery potential. Conditions measured or determined are, as follows:

1. Water level fluctuation (by actual measurement).
2. Inlet (flow, spawning, and rearing potential, overwintering benefits).
3. Outlet (flow, spawning, and rearing potential).
4. Natural reproduction.
5. Vegetative or material type of shoreline.
6. Type of bottom shoal area.
7. Percent shoal area.
8. Depth (maximum and average by actual measurement).
9. Size.
10. Measure of fertility.
11. Altitude.
12. Aspect.
13. Fish size, condition, and numbers.
14. Land type.
15. Parent material.

16. Aquatic plants.

17. Terrestrial plants.

Most measures of conditions were done ocularly with quality measurements. Some, such as depth, fish size, etc., were done by actual measurement.